No. 308. Vol. XXVII. JUNE, 1946

CONTENTS

Editorial Comments

South African Port Enterprise.

The past year has been remarkable among other things for the completion of two great port enterprises: one in South Africa and the other in Australia. In both cases, graving docks of outstanding magnitude have been created. We must confine our attention at the moment to the first of these achievements, and in this issue, through the courtesy of the South African Railway and Harbour Administration, we are enabled to present to our readers a detailed account of the new Sturrock Dock at Cape Town.

The Sturrock Dock (so named after the South African Minister who was mainly responsible for its construction) was opened on 18th September, 1945, and is an essential complement of the important development of the harbour at Cape Town, which took the form of a large new Basin, now known as the Duncan Dock. Cape Town lies at the head of Table Bay on the northern side of the peninsula of which Table Mountain is so striking a feature. The settlement was founded in 1652 by Van Riebeck, and, at first was merely a collection of a few dwellings under the shelter of a fort. The coast line in the neighbourhood of the Cape of Good Hope is generally bold and rocky, with numerous inlets characterised by many local and minor currents. From a harbourage point of view the situation therefore is by no means good. The Cape, indeed, was originally named by Bartholomew Diaz, the Portuguese navigator, who discovered it in 1486, the Cape of Storms (Cabo Tormentoso). The accommodation for shipping in the port has had to be protected by a massive enclosing breakwater, which even in its extended and amplified state has failed to afford complete protection from a periodic tidal surge, or "run" as it is termed locally, which has been described in the issue of this Journal for April, 1943 (see article on "Range Action in Harbours," by Mr. George Stewart). It may be added that it was also the subject of a special Comment in the May issue of this year.

Despite this untoward characteristic, the Port of Cape Town has grown greatly in influence and importance. During the late war it proved of inestimable value as a port of call on the Far Eastern route, especially during the period when the Mediterranean was a highly dangerous, if not impossible, thoroughfare for shipping. At the present time there is accommodation in the Duncan Dock for 14 deep-draughted vessels and it is capable of handling some 8 million tons of goods annually. With the completion of the new works the port has before it a future of great promise.

South Wales Port Problems.

Reference has already been made in previous issues of this Journal to the alarm felt and openly expressed by South Wales Port officials and Chambers of Commerce at the serious decline during the past twelve months in the volume of trade passing through the ports of that locality. In further demonstration of this attitude, we have lately received from the body known as the South Wales and Monmouthshire Joint Ports Committee, a communication calling attention to a Report of the sub-committee appointed specially to investigate the factors militating against the welfare of the ports in question. The Report, is a voluminous document and covers a good deal of ground, which, while admittedly affecting in some degree the prosperity of the port undertakings concerned, is not strictly germane to the province of this Journal and is, in fact, only remotely associated with port operation. It is essentially a dissertation on the trend in this country of the flow of exports and imports within a certain area and an analysis of the channels through which they move under impelling influences. Naturally ports have to depend largely for their revenues on the volume of goods which passes through their transit sheds and warehouses and over their quays for shipment and discharge, but the originating causes are to be found rather in the domain of economics than in that of port administration.

So far as the substance of the enquiry bears on port affairs, we give on another page a series of excerpts from the Report, from which our readers will be able to form some idea of the serious problem with which the South Wales Ports are confronted. Following a period of prosperity under war-time conditions when shipping traffic had, of necessity, to be diverted from ports on the Eastern Coast of the country, owing to their extreme vulnerability to aerial bombardment, the group of ports at the entrance of the Bristol Channel are now experiencing a heavy, and even disastrous, slump, not merely through the withdrawal of what may be termed their temporary war-time trade, but in consequence of the depression in those local industries and activities with which they were closely associated in pre-war days. The predominant characteristic of the ports was their staple traffic in coal and its bye-products, and scarcely less prominent were the exports of tinplates and steelwork, and the importation of pitprops for the mining industry. For these purposes, the ports had equipped themselves at considerable expense with specialised handling appliances, and these, through lack of the commodities in question, are now standing idle. South Wales

Editorial Comments—continued

coal no longer finds its way abroad to foreign markets in anything like the volume of pre-war years and the export of tinplates and steel, crippled during the long period of hostilities, will take some time to recover.

It is impracticable within the limits of a short Comment to do justice to a Report so weighty and exhaustive. It should be studied very earnestly by all those whose interests are in any way affected. The situation certainly bristles with obstacles. It is difficult to see how Port Authorities, as such, can take effective action to remedy matters, though other bodies, such as Railway Companies may be able to do something. While sympathising with, and even commending, many of the recommendations made by the Committee, yet, in so far as the proposed intervention of the Government is concerned "as long as food rationing and commodity controls remain," we feel bound to utter a word of caution against interference with the natural interplay of economic forces. The suggestion that there should be directive instructions to shipowners to use certain ports for their cargoes seems to us to strike at the root of the free exercise of judgment in commercial enterprise, and we can hardly conceive that the policy will be wise or palatable.

Apart from this defect, the Report is generally commendable and everyone would undoubtedly welcome a solution of the problem which is so serious in its consequences to the welfare of the ports of South Wales.

Belfast Harbour Airport.

The association of aviation with commercial harbours, at one time speculative, is no longer in question and may almost be said to be axiomatic, especially as concerns hydroplanes and flying boats. The requirements of this class of aircraft in regard to points of take-off and landing can only be met along the coastline of a country by means of sheltered water areas of reasonably ample extent. Aeroplanes in general, not susceptible of being water-borne, do not necessarily come within this category, but there can be little doubt that in many cases, a seaboard situation offers important advantages, both as regards conditions of arrival and departure and reduction of distance of route. Such has been the case at the Port of Belfast, where the Harbour Board, recognising the desirability of providing the necessary facilities for air transport have been at considerable outlay in constructing at a site in Sydenham, adjacent to the harbour and lying within the port area, a commodious up-to-date aerodrome, with appropriate runway and all the necessary appurtenances for an airway terminus. It was described in our issue of April, 1938, on the occasion of its opening by Mrs. Neville Chamberlain. During the late war, this aerodrome proved of the greatest utility and service, and it has, therefore, come as somewhat of an unpleasant shock to the Harbour Board to learn that the site is not viewed with favour by the Ministry of Civil Aviation in connection with their plans for the development of British aerial transport. The Under-Secretary of the Ministry (Mr. A. H. Wilson) recently paid a visit to Belfast and from his remarks at a press conference it is to be inferred (more by implication and suggestion, perhaps, than by direct statement) that the aerodrome is not to be included in the operation of future scheduled air services.

Having expended a sum of the order of £100,000 on the installation, and contemplating extensions of some importance, the nature of which is outlined on a subsequent page, the Harbour Commissioners are naturally disappointed by this adverse attitude of a high personage in the Ministry and they have accordingly obtained an expression of opinion from their Aeronautical Consultant, Air-Commodore Sir Adrian Chamier, who, in a long and detailed report (too technically concerned with the manœuvring of aircraft for reproduction in these columns) contests the view that the Sydenham aerodrome is in any way defective or unfit for use by the largest and most modern machines, and unequivocably states that "the harbour airport offers unrivalled facilities and it would be the most short-sighted policy in the world to abandon them."

The weighty reasons given for this decision, backed by the concurrence of airmen and technical experts, who have used the Belfast airport for a number of years, demand full consideration and we trust that the representations of the Harbour Authority will succeed in removing the prejudices of the Ministry against the further development of this important undertaking.

Radio Aids to Navigation.

An informal International Meeting on Radio Aids to Marine Navigation, attended by delegates from more than 20 maritime nations, was held in London from the 7th to the 22nd of last month. The objects of the Conference were to exchange information on the work being done in the United Kingdom and in other countries in the field of radio navigational aids, and to discuss the problems affecting their international adoption.

Discussions and lectures were held and provision was made for the delegates to visit factories and inspect the latest technical equipment. Opportunity was also provided to attend practical demonstrations at sea.

At the closing session it was generally agreed that Radar can give service on the high seas and in narrow waters alike by disclosing obstacles projecting above the waterline. The aid it can give however, is limited at present to areas where a ship can find land marks, but it has already been found of value for landfall, coasting and pilotage operations, especially during periods of fog or poor visibility.

Although Radar is the most advanced system so far known, and perhaps for that reason, was given the widest publicity, other systems such as Decca, Gee, Consul and Loran were also considered. It was recognised that further experiments would have to be carried out and large-scale trials are being arranged that will give additional information.

Primarily, of course, the new navigational aids are chiefly applicable to shipping, but port officials are becoming increasingly interested in the new developments insofar as they affect their own problems of navigation in confined waters. It is significant that some harbour authorities are already experimenting with Radar as a means of generally supervising their area of control, and the time is perhaps not far distant when a harbour control officer, by the combined use of shore-based Radar and an efficient pilotage system, will be able to exercise full control over shipping in the harbour and its approaches in all weathers.

World Shipbuilding Returns.

The Quarterly Shipbuilding Returns issued by Lloyds Register of Shipping for the quarter ended 31st March last, continue to show a gratifying upward trend, despite the difficulties with which the shipbuilding industry is confronted at the present time.

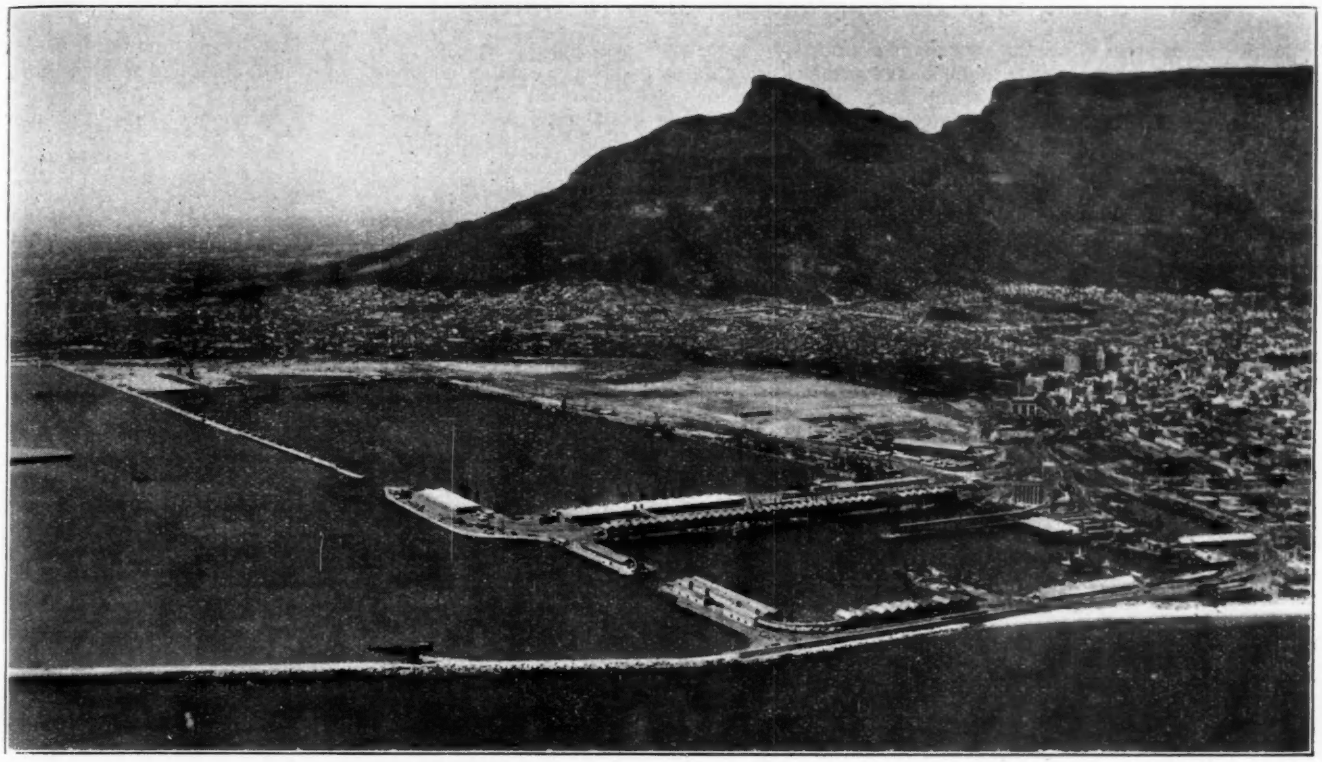
Merchant vessels under construction in Great Britain and Ireland showed an increase of 63,293 tons in the work in hand as compared with the figures for the previous quarter. The present total of 1,676,103 tons is also greater by 440,299 tons than the tonnage which was being built at the end of March, 1945, and is the highest figure of tonnage under construction in Great Britain and Ireland recorded since June, 1922.

For the first time since June, 1939, figures of Merchant vessels under construction abroad are now given. The total is 1,580,823 tons, which is about 487,000 tons less than the work in hand at the end of June 1939. It is to be noted, however, that no figures are included concerning Russia, while those for Spain are incomplete.

Compared with war-time peak levels, there is a considerable decrease in the tonnage being built in the United States of America, which has only 587,278 tons under construction. The figures for other countries abroad are:—Sweden, 205,015 tons; Italy, 156,190 tons; Holland, 141,915 tons; Spain, 110,975 tons; Belgium, 104,940 tons; and Denmark, 103,905 tons.

It will be seen from the foregoing, that the total tonnage under construction throughout the world (apart from those countries excluded, as mentioned above) amounts to 3,256,926 tons, of which 51.5 per cent. is being built in Great Britain and Ireland, and 48.5 per cent. abroad.

Bearing in mind our need for foreign orders, it is to be regretted that only about 105,000 tons, or 6.2 per cent. of the tonnage now being built in this country are intended for registration abroad or for sale. Nevertheless, although this country still has much leeway to make up before attaining its pre-war record of supremacy in shipbuilding, the figures for the last three months are distinctly encouraging.



Aerial view of Docks, Cape Town

Table Bay Harbour (Cape Town) and the Sturrock Graving Dock

An Important South African Port Development*

Description of the Port

THE PORT OF CAPE TOWN has developed steadily since 1910, when the Union of South Africa came into existence, but the rate of progress was greatly accelerated after the outbreak of war in 1939, when the port's strategic position made it one of the vital links of communication on the great ocean routes from Europe and America to New Zealand, Australia and the Orient. Fortunately, the port was able to meet all demands. It gave sanctuary to some of the largest ships afloat and provided all the necessary facilities for re-victualling and refuelling.

The harbour proper consists of three basins, a brief description of each being as follows:—

The Alfred Basin has an area of 8½ acres and an average depth of 23-ft. Originally, it was the only dock in commission, but it is now used almost entirely by fishing craft and trawlers. For the repair, cleaning and painting of ships, the following facilities are available:—

The Robinson Graving Dock, named after Sir Hercules Robinson, Governor of the Cape Colony, completed in 1882, is 500-ft. long and 56-ft. wide with an entrance depth of 26-ft. at high tide.

The patent slip, completed about the same time, has a capacity of 750 tons and has been fitted recently with two side slipping berths, each of 400 tons.

The floating dock "James Cochrane" is able to lift craft of 450 tons.

There are three boat slips for yachts and fishing cutters.

The Victoria Basin, 67 acres in extent, with eleven berths and an average depth of 34-ft., was constructed subsequently. The dominating feature is the grain elevator, in which can be stored 30,000 tons of grain. Appliances are attached to the elevator for loading ships at the rate of 1,000 tons per hour. A special quay is provided for the landing of fish under cover, and immediately adjacent are modern cleaning sheds and stores connected with the industry, the whole being known as the fish market. In this locality, a factory has been established for dealing with fish offal and the production of fish meal and fertiliser.

Special berths, where proper precautions can be taken, have been set aside for ships containing petrol and paraffin to discharge their cargoes by pumping direct into the storage tanks of the oil companies.

The Duncan Basin, which was completed in 1943, is 6,000-ft. in length and 2,000-ft. wide, with 290 acres of unbroken water surface having an average depth of 40-ft. at low water. Berthing accommodation, where cargo can be worked, is available for 14 large ships. Shelter is given to the entrance of the docks by a breakwater, which extends seawards for a distance of approximately half-a-mile.

The western quay wall has two modern double-storey cargo sheds of reinforced concrete construction, each 500-ft. long and 120-ft. wide and fitted with 3-ton electric roof cranes and lifts of 5-ton capacity. Each floor in these sheds can be loaded to the extent of 400 lb. per sq. ft. The foundations are carried down to solid rocks on reinforced concrete piles. It is planned to construct additional sheds of a similar design in the near future.

Some 15,000,000 cubic yds. of sand and clay were dredged from the Duncan Dock and its approaches to give the necessary depth of water. More than 360 acres of the foreshore were reclaimed

*Based on information contained in a Brochure issued in September, 194[illegible], by the South African Railways Administration.

Table Bay Harbour and the Sturrock Graving Dock—continued

to provide room for new railway development and city expansion. The western quay wall required 25,000 concrete blocks varying in size from 12 to 16 tons, and 79,000 cubic yds. of concrete for the foundations and the top. The estimated weight of the whole wall is about 500,000 tons.

The eastern side of the basin is enclosed by a sheet steel pile structure, 40-ft. wide and 4,000-ft. long. As and when occasion demands, this will be widened to 300-ft. and will then provide a commercial quay and berthing accommodation, with crane and cargo shed facilities.

The quays of the Victoria and Duncan Basins are equipped with modern electric cranes of 4-ton and 15-ton capacities and cargo sheds of ample size. Special facilities exist for the pre-cooling and handling of fruit, and loading can be effected at four berths simultaneously. The capacity of the stores is approximately 6,200 shipping tons.

Every berth in the harbour is equipped to provide fuel oil to shipping, much time being saved thereby, as ships are able to refuel whilst discharging or loading cargo.

The Harbour in War-Time

Prior to 1939, besides the regular weekly sailings of mail ships, passenger and cargo steamers called at Cape Town in ever-increasing numbers, but when the Mediterranean was closed to shipping during the crisis years of the war, the port was frequently congested. The largest ships of the Allied merchant navies, fitted as troop transports, called in convoy many times and even when adverse weather conditions prevailed, they had to be berthed and unberthed without delay.

During the war period up to November, 1944, the following ships were dealt with:—

Merchant Vessels	Number	Gross Tonnage
British	10,420	50,319,953
United States of America ...	1,721	11,646,046
Other Allied and Neutral ...	2,672	16,910,202
Warships		
British	1,203	4,458,202
United States of America ...	12	52,944
Other Allied and Neutral ...	32	98,877

Of these vessels 23 battleships (622,714 gross tons), 20 aircraft carriers (310,122 gross tons) and 244 cruisers (2,857,149 gross tons) arrived at and departed from Cape Town.

At one stage in 1940-1943, any vessel which entered dock during early morning for bunkers, stores and water had to unberth the same evening to enable another vessel to take its place. Frequently it occurred that twenty ships docked and undocked in one day.

The largest vessel docked at the port was the *Aquitania*, which called on three occasions, while the biggest concentration of merchant vessels in the docks and at anchor in the bay at any one time was 103 (34 in dock and 69 in the roadstead, aggregating 788,000 tons).

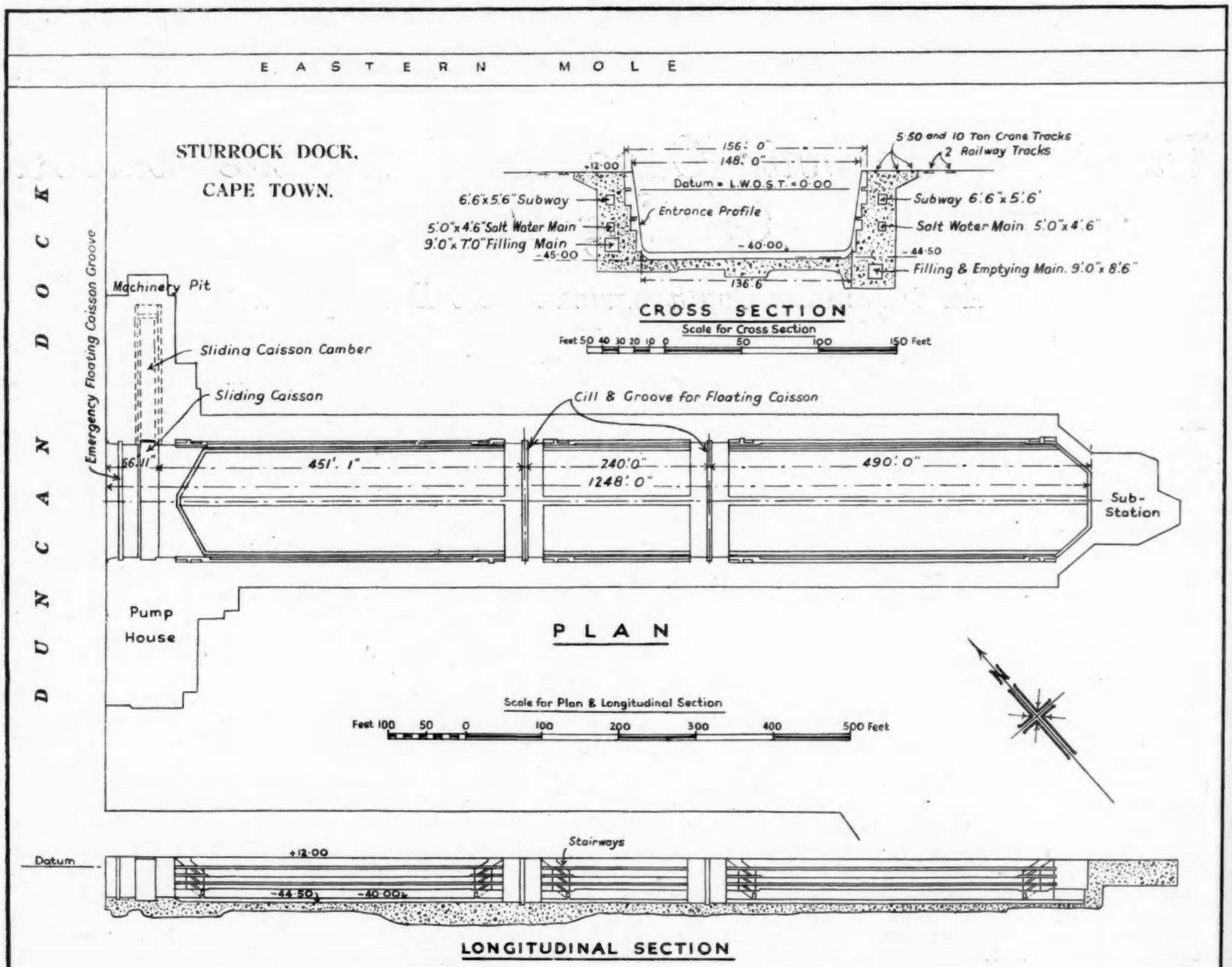


Table Bay Harbour and the Sturrock Graving Dock—continued

At present there is berthing accommodation for 27 vessels, but this number can be increased under special circumstances. Six repair berths are available at the New East Mole for moderate-sized vessels.

Four ocean-going tugs are stationed at Table Bay Harbour. These tugs tow disabled vessels to port, perform salvage duties, and help to extinguish fires on board ships.

The Sturrock Graving Dock

When war broke out in 1939 the ship repair industry was in its infancy in the Union. The country was then served by the following dry docks:—

The Robinson Graving Dock—Cape Town.

Total docking length	529-ft.
Width at entrance	68-ft.
Depth at sill at H.W.O.S.T.	26.75-ft.

The Selborne Graving Dock—Simonstown.

Overall docking length	756.4-ft.
Width at entrance	95.1-ft.
Depth on sill at H.W.O.S.T.	36.5-ft.

The Prince Edward Graving Dock—Durban.

Normal docking length	1,150-ft.
Width at entrance at cope	110-ft.
Depth on sill at H.W.O.S.T.	41-ft.

All these docks have rendered great service. The Robinson Dock served its purpose well, but the need for improved dry-docking facilities at Cape Town was recognised as far back as 1921 by shipping and harbour interests. They failed, however, to convince successive governments that the expenditure would be justified. After 1939 the demand for a dry dock, capable of accommodating ships of all sizes and types, grew progressively more insistent, while the emergence of South Africa as an important agricultural and industrial producer in a world sense indicated the prospect of the dock being used to a reasonable degree in the post-war period.

When the Minister of Transport, Mr. F. C. Sturrock, visited Great Britain in 1942, he had become convinced that the case in favour of a dry dock capable of meeting all discernible future requirements was sound. He successfully negotiated the final arrangements for construction and equipment and enlisted the support of the British Government, which, through the British Admiralty, agreed to pay for and deliver in the Union all the necessary equipment.

It was then decided to send a representative to England to design, in conjunction with the Admiralty, a graving dock that would meet the needs of both merchant and naval vessels. Preliminary drawings were prepared in England, but the detailed construction drawings of the structure work were done by the technical staff of the South African Railways and Harbours Administration at Cape Town.

Since graving docks, as such, are not payable commercial propositions, a dock was designed capable of being used not only for repair facilities, but also as a dock for the discharge of bulk cargo, and it was decided to go ahead with all possible speed. In less than three years the work was completed, and although there are docks whose dimensions are greater in one or other respect, the dock at Cape Town is not exceeded in all its dimensions by any other dock in the world.

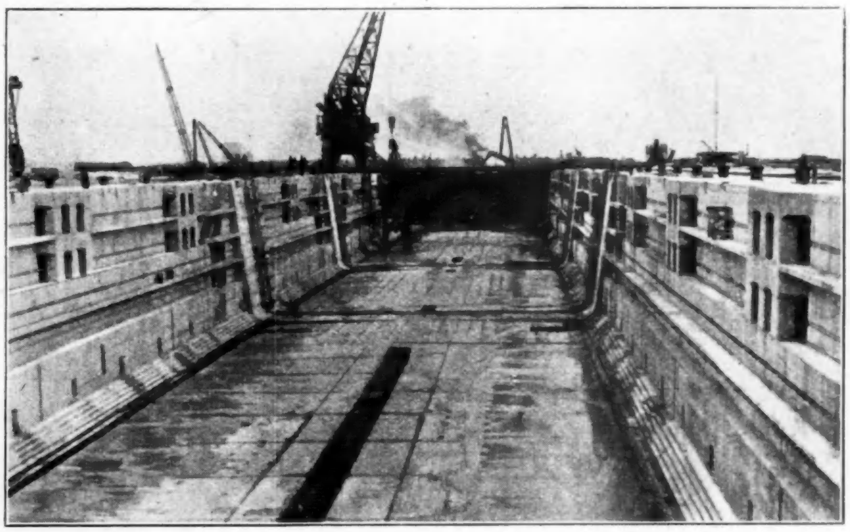
Prior to authority being received to proceed with the construction of the Cape Town Graving Dock in 1942, survey work was done by the grab dredger *Springbok*, which was commissioned for this task on December 12th, 1938.

In the same year, in addition to the trial holes grabbed by this dredger, core borings were taken at suitable intervals over the area of the proposed site in order to determine the physical features of the substructure. Since the dock was to be constructed in the dry, the site was enclosed by a dam within which was driven a continuous core of steel sheet piping.

Preparation of the Site

Advantage was taken of the services of Messrs. Hollandse Aanneming Maatskappy, at that time engaged on the reclamation of the Duncan Dock, and this firm commenced work on the reclamation dykes early in April, 1942. The firm also carried out dredging of the site by bucket dredger before it had been de-watered. These dykes were made up by dumping dredged material from barges up to approximately 5-ft. below L.W.O.S.T. Above this level, rubble retaining dykes were built on either side of the proposed steel sheet pile core up to level of 8-ft. above L.W.O.S.T., and the space between these rubble walls was then hydraulically filled with sand.

A gap of 160-ft. was left in this cofferdam for the passage of dredgers and rock-breakers from the Duncan Dock to the graving dock site. The work of driving inter-locking steel sheet piles into the sand core and underlying deposited soft rock spoil from the dredgers was carried out without any undue difficulties, the steel piles readily driving through the material until finally coming to rest after penetrating some 3 to 4-ft. into the rock strata of the Malmesbury shales. Three piling frames 55-ft. in height were employed, commencing operations on March 1st, 1943, the final closure pile being driven on August 9th, 1943, about six months later.



View of completed Dock with caisson in position

The total weight of piling driven was 3,078.1 Cape tons, representing a total length of 4,791-ft. of continuous piling. This method of shutting off the waters of the bay from the site of operations was so successful that two 8-in. centrifugal pumps, working intermittently, were able to cope with not only what water seeped through the piling, but also the subterranean springs, evidence of which was subsequently encountered on excavating the rock underlying the site.

Placing Construction Cranes

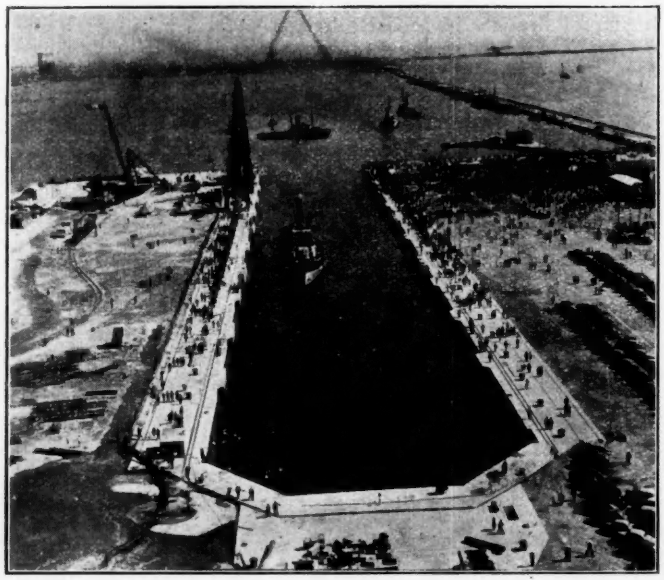
Before closing the entrance gap in the cofferdam, four dockside cargo-handling cranes of 4-ton capacity, earmarked for construction purposes, were removed from the Duncan Dock and placed in position at the head of the graving dock site through 50-ft. of water by means of the 60-ton floating crane.

Novel De-watering Method

De-watering of the site was commenced on August 5th 1943, and completed on August 23rd of the same year. This was done by a novel method. Two 16-in. diameter electrically-driven

Table Bay Harbour and Sturrock Graving Dock—continued

centrifugal pumps were mounted on a pontoon inside the cofferdam. A single 24-in. diameter pipe line 60-ft. long was connected with the pontoon to a pipe line supported on staging at 8-ft. above L.W.O.S.T. and led over the steel sheet core to discharge into the Yacht Basin. A flexible rubber joint was made at either end of the 60-ft. long pipe line, permitting the pontoon to sink with the water level inside the cofferdam until it finally came to rest on the bottom of the excavation at 40-ft. below L.W.O.S.T. Thus



View of Sturrock Dock immediately after opening

at the commencement of pumping, the 60-ft. length of pipe line was at an angle of approximately + 30 degrees to the horizontal, and at the end at approximately—30 degrees when the pontoon came to rest on the bottom of the excavation.

As the water level fell in the cofferdam, the contractors commenced the construction of temporary roads and drainage works. The ooze overlying the dredged surface, in certain areas up to 7-in. in depth, greatly hampered the work, but drilling and blasting was started on September 3rd, 1943. Excavation down to the required depth as indicated by the nature of the rock encountered and the design of the dock was done by means of 20 RB excavators and 3-ton tip lorries.

Dry Site

The site was found to be remarkably dry—two 8-in. electric pumps worked intermittently, as mentioned previously, sufficed to keep the job dry. Two main pumping stations were established, one near the head of the dock and the other at the entrance. The dock is founded on Malmesbury shale which has proved to be fairly good in places, so that at the head of the dock it has not been excavated deeper than 51-ft. below low water, giving a floor thickness of 6-ft. This thickness is, however, not sufficient to resist any upward hydrostatic pressure; the latter has, therefore, been relieved by a system of 6-in. open-jointed earthenware vent pipes in french drains, which in turn are led up to the dockside drains leading to the main dock sumps in the floor. In other places, mainly about the middle of the dock the rock proved to be unsatisfactory, being relatively soft and much jointed, probably due to a geological fault traversing the longitudinal axis of the dock at a slight angle. Here the excavation was taken down to 80-ft. below L.W.O.S.T. resulting in a floor thickness of 35-ft. 6-in. in this locality.

Concreting

Whilst the earthworks were under way, preparations were being made for the concreting of the dock. The main concrete mixing station, consisting of three 2 cub. yd. and one 1 cub. yd. " Smith " electrically-driven mixers situated well below ground level, was erected.

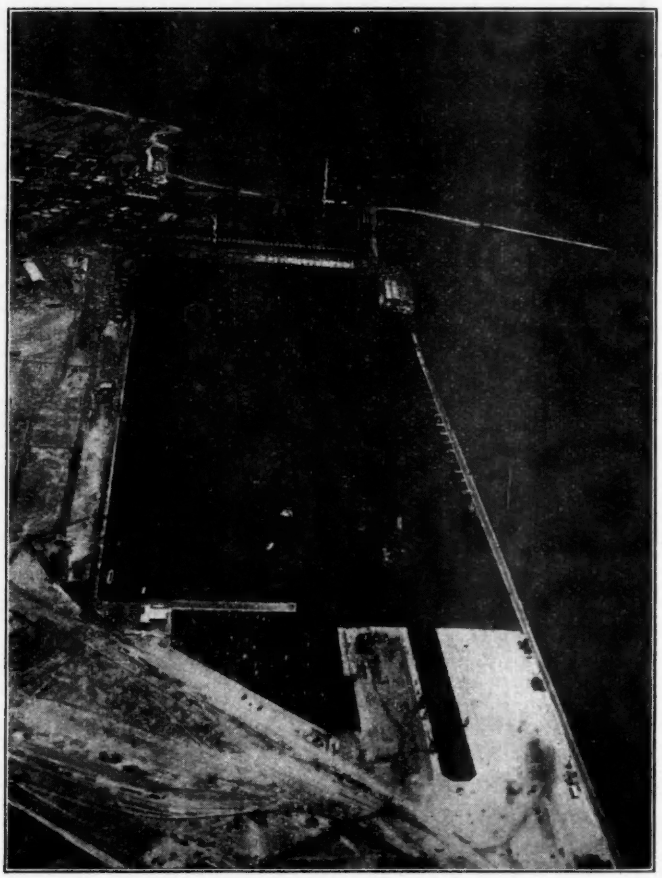
Four 100-ton cement hoppers of steel were built above these mixers and tracks laid at ground level from which sand and stone could be tipped from cocopans direct into the mixers.

A system of narrow-gauge railway track was provided, along which petrol-driven locos. hauled trains of 1 cub. yd. tip trucks from the stone stacks and from the sand pit to the main mixing station.

In addition to the main mixing station, through which 90% of the concrete in the job passed, a special mixing station was provided. Here only one 1 cub. yd. " Smith " mixer was installed and the concrete mixer was used for the special facings to all exposed surfaces of the dock walls and culverts.

Cement Supplied in Bulk

The greater proportion of the cement used on the job was supplied in bulk, forty railway grain trucks being specially converted to handle it in this form. The cement was pumped direct from these trucks into the cement hoppers situated above the main mixers by means of Fuller Kinyon cement pumps and convey system. The total cement used in bags amounted to 536,505 pockets each containing one cub. ft., while the amount handled by the Fuller Kinyon system was 1,333,305 cub. ft. The pumps were operated by dry compressed air at 30 lb. per sq. in. pressure.



Aerial View, showing Sturrock Dock in foreground

When the hoppers were full, the cement was conveyed through pipes to a cement storage shed whence it was again pumped into the hoppers when required.

Travelling Steel Shutters

Owing to the extreme shortage of timber for shuttering, as much of the main walls as possible was designed to be suitable for the use of travelling steel shutters. The subway and filling culverts

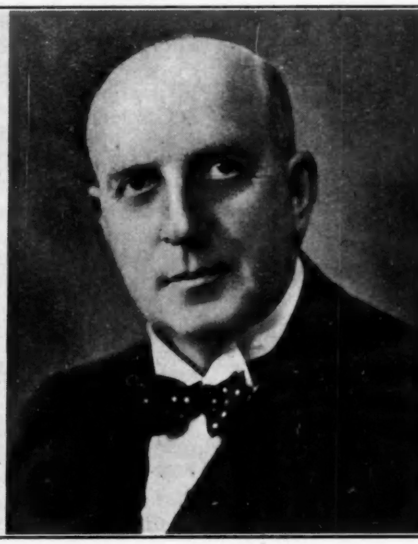
Table Bay Harbour and Sturrock Graving Dock—continued

also were constructed by means of steel shutters, although these were not capable of travelling like the main shutters of the walls. Altogether 444 tons of steelwork were used in the manufacture of shuttering and the concrete batching plants.

Method of Handling Concrete

Coming now to the method of handling the concrete from the mixers to the job, a sunken roadway passed below the mixing stations and the concrete was chuted direct into 1 cub. yd. and 2 cub. yd. concrete skips with collapsible bases. These skips were conveyed by means of 5-ton flat lorries to the various concrete sites, at which points they were picked up by 4-ton wharf cranes, of which there were seven employed in the work, and their contents deposited inside the boxes being concreted. All concrete was thoroughly vibrated, as density was a most important factor in work of this nature. The layout enabled the placing of from 1,600-1,800 cub. yds. of concrete per day during the peak period, a maximum of 2,132 cub. yds. in 9½ hours being recorded on June 23rd, 1944.

MR. J. S. de V. von WILLICH, B.Sc., A.M.I.C.E. (Chief Civil Engineer South African Railways)



THE HON. F. C. STURROCK, M.P. (Minister of Transport Union of South Africa)

LT.-COL. D. E. PATERSON, O.B.E., M.C., B.Sc., A.M.I.C.E. (Asst. Chief Civil Engineer South African Railways)

Dimensions of Dock

The effective length of the dock is 1,181-ft. when the sliding caisson at the entrance is in position, which means that the largest ships afloat can be accommodated with 120-ft. spare. Moreover, when the emergency caisson stop is used, the effective length of the dock can be increased to 1,212-ft. 5-in. The depth of water on the entrance sill at H.W.O.S.T. is 45-ft. 9-in., which will readily take the largest ships afloat.

The width of the dock at entrance cope is 148-ft. and the main dock walls have a batter of 1 in 8, giving a width of 136.3-ft. at a depth of 34-ft. below low water, and below this level there is a curved portion which reduces the width to 124.4-ft. at sill level, that is at 40-ft. below L.W.O.S.T.

Partitioning the Dock

By means of a floating caisson and two inner caisson grooves, the dock may be so divided that small ships of 469-ft. and under may be docked at the head of the dock and a larger vessel not exceeding 674-ft. in length can be accommodated in the remaining outer portion of the dock. Alternatively, the docking lengths may be 709 and 434-ft. respectively.

The dock is equipped with cast-iron keel blocks, capable of withstanding loads of 150 tons per ft. forward, and movable cast-iron bilge blocks which, when used as keel blocks to accommodate vessels, two of which can be docked abreast if necessary, will be subjected to loads of 75 tons per ft. forward.

The centre line of the dock coincides, as nearly as possible, with the direction of the prevalent winds, i.e., north-west and south-east. The pump house is situated on the starboard side of the entrance to the dock and the chamber into which the sliding caisson is hauled during the docking and undocking of ships is on the port side. A sub-station containing the electrical equipment is at the head of the dock. The dock contains 54,800,500 gallons of water at H.W.O.S.T. when there is no shipping therein and with the sliding caisson in position; it can be dewatered in 4½ hours by means of three 4-ft. 6-in. diameter electrically-driven centrifugal pumps. It can be completely filled in 1¼ hours by means of two 9-ft. diameter culverts through which the water passes at the rate of 52-ft. per second. These filling mains are fitted with 7-ft. diameter electrically-operated control valves. With a ship in the dock, these times will be somewhat reduced.

The dock is equipped with one 50-ton, one 10-ton and two 5-ton electrically-operated dockside cranes, the 50-ton and 10-ton cranes being on a common track of 25-ft. centres and capable of approaching both sides of the dock by means of a track extension and points supported on reinforced concrete piles at the head of the dock.

Dock Pumping Machinery

The pumping machinery for this large dock is to the latest and most modern design, and was supplied by Gwynnes Pumps, England. The equipment consists of three main pumps, two drainage, one circulating, two fire and two seepage pumps; all pumps are of the centrifugal type, hydraulically balanced axially and direct driven by electric motors through all-metal flexible couplings. The main pumps are of the split-casing type, horizontally driven. The auxiliary units are of similar design but with vertical spindles, having extended shafting with motors mounted at operating platform level.

Careful consideration has been given to the selecting of the materials to prevent corrosion by salt water, particularly with regarding to the casing, impellers and spindles.

Emptying the Dock

For de-watering the dock, three pumps have been installed, each capable of dealing with a maximum quantity of 23,000 long tons per hour (83,500 g.p.m.). The mean quantity is 19,600 long tons per hour (71,000 g.p.m.) during the de-watering period.

Table Bay Harbour and Sturrock Graving Dock—continued

These pumps have a 4-ft. 6-in. diameter delivery branch with a 5-ft. diameter suction branch and are driven by 1,200 h.p. electric motors. Each pump weighs approximately 30 tons and the motor 17 tons.

To deal with any water accumulating in the culverts while the dock is empty, two 18-in. pumps have been supplied dealing with an average quantity of 2,000 long tons per hour (7,300 g.p.m.). The 10-in. circulating pump installed is for supplying sea water for condensing purposes to vessels in dock and is capable of discharging 2,100 gallons per minute.

Protection Against Fire

For fire-fighting purposes for vessels in dock as well as for dealing with fires in the dock area, two 10-in. pumps are situated in the pump house, supplying water to a ring main around the dock. Each pump is capable of discharging 1,825 g.p.m. and maintaining a pressure of 80 lbs. per sq. in. in the main when the dockside hydrants are closed. These pumps are remote controlled by switches at various points around the dock.

Dock Control Valves

The layout of the main culverts and valves is so arranged that the whole dock can be flooded, or the inner dock alone, or the outer dock alone as required. The filling is carried out through culverts on either side of the dock, having inlets from the Duncan Basin in the east and west return walls. The de-watering is from the west side only, using the same culverts but by operating certain valves, diverting the flow into the main suction chambers to be dealt with by Gwynnes' pumps.

Quantities Handled

The magnitude of the undertaking may be gathered from the quantities given below:—

1. 923,000 cub. yds. (barge measurement) of material were placed in the reclamation of the graving dock site.
2. 3,240 steel sheet piles, of lengths varying between 35-ft. and and 60-ft., were driven to enclose the site.
3. 716,000 cub. yds. (barge measurement) of material were reremoved in the wet by bucket dredgers before the closing of the entrance gap.
4. 268,500 cub. yds. (solid) of material were removed by excavators and lorries in the dry.
5. 1,500,000 cub. yds. (barge measurement) of rock and soft material were removed in the graving dock entrance channel, which was dredged to—40.00 L.W.O.S.T.
6. 400,000 cub. yds. of additional backfill were placed hydraulically by reclamation dredger behind the completed walls of the graving dock.
7. 340,000 cub. yds of concrete are contained in the structure.
8. 3,900 tons of cast-iron went to the manufacture of the keel and bilge blocks.
9. 18,500 cub. ft. of South African ironwood were provided for the capping blocks on the above keel and bilge blocks.
10. Approximately 2,000 tons of reinforcing steel are in the structure.
11. 260 tons of bitumen, 5,000 sq. yds. of malthoid and 26 tons of powdered asbestos were used in waterproofing the construction joints.
12. 300 tons of rails were used in the fabrication of permanent crane tracks.
13. Approximately 650 tons of scrap 80 lb. and 96 lb. rails were cut and welded into slabs, which, when used as ballast in the caissons, give the greatest weight for the least amount of space taken up.
14. The total electric power consumed by the construction plant amounted to 3,500,000 units. The total h.p. of the plant installed was 2,830, of which 235 h.p. was standby.

Steel Caisson

The sliding caisson, the steel work for which was fabricated in Scotland by Messrs. Sir William Arrol, was constructed in the graving dock by Messrs. Dorman Long (Africa), Ltd. The construction was commenced in July, 1944, the fabricated steel work amounting to approximately 1,200 tons.

The floating caisson was constructed on its side in the dry on the west side of the graving dock. The site eventually flooded and breached enabled the floating caisson to be towed into position. The concrete work having been practically completed, the dock was flooded by means of a sluice gate in the west side of the cofferdam.

First Tests

Flooding commenced on April 10th, 1945. After carrying out flotation and inclination tests on the caisson, it was eventually sunk into the runway wherein satisfactory haulage tests were made. Subsequently, the dock was de-watered with the caisson in position.

Commencing on April 27th and using the two 18-in. drainer pumps in the pump house, the dock was dry on April 29th, after 53 hours of continuous pumping, the meeting faces of the granite proving watertight against the greenheart faces of the caisson. After these satisfactory tests, reclamation dredgers commenced their task of backfilling the dock walls with sand obtained from Table Bay. The subsequent removal of the cofferdam at the entrance to the dock was carried out by means of partially dredging away the earth mounds supporting the row of steel sheet piling, the individual piles being satisfactorily extracted by means of a No. 9 McKiernan Terry hammer converted to strike upwards and suspended from a pair of 15-ton sheerlegs mounted on a floating pontoon.

The deepening of the cofferdam site at the entrance was subsequently carried out by means of a floating rock-breaker, the broken rock being removed by bucket dredger

New Chinese Port

Tangku Harbour

The new harbour that is under construction at Tangku, at the mouth of the Hai-ho, some 30 miles from Tientsin, promises to be one of Asia's finest and largest ports of call for ocean-going liners. It is also to have its own airfield and seaplane base.

The harbour, which was half finished by the Japanese, will take another two years to complete. It is being built on the north bank of the Hai River. The navigation channel will be 200 yds. wide and over 4 miles long. At present the water is 21-ft. deep at ebb tide, but dredging is in progress in order to accommodate vessels with a deeper draught. Training walls have been built north and south of the harbour; the one in the south to protect the harbour against silt from the Hai River, and the one in the north to shield it from the north-west wind. A canal has also been constructed to link the harbour with the Hai River, and railway spurs have been built to connect the wharves with the Peiping-Mukden railway.

The Chinese Government is continuing to employ the Japanese technicians already engaged in the construction of the new harbour, and they are to have the additional help of American experts. Materials left over by the Japanese will, it is believed, be sufficient to complete the work.

Tientsin itself was opened as a port in 1860. Lying at the junction of the Peiping-Mukden and the Tientsin-Pukow railways, it handles cotton from Hopei, Shansi and Shensi, coal and iron from Shansi, and wool and fur goods from the north-west. There are numerous factories in the area between Tientsin and Tangku. Some of them were built by the Japanese during the occupation, including iron, steel and synthetic petroleum factories, all of which will undoubtedly facilitate the development of the city.

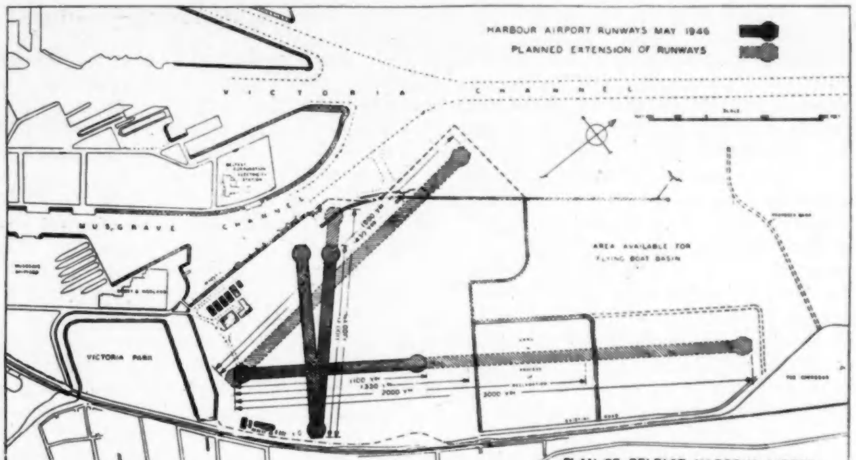
New Chairman of Clyde Navigation Trust.

Mr. James Leggat has been appointed Chairman of the Clyde Navigation Trust in succession to the late Mr. William Cuthbert. Mr. Leggat has been a ratepayers' representative on the Trust since 1936 and deputy-chairman since 1941.

Belfast Harbour Airport

Proposed Development

On this page will be found a plan showing the contemplated extension of the airfield at Belfast Harbour, which is referred to in an Editorial Comment in this issue. At present, the airfield is traversed by three runways, shown by double cross hatching on the plan: two of **900** yds length and the third of 1,150 yds. The ground is already consolidated to permit of the extension of the long runway to over **1,300** yds. With this extension, the airport can meet the extreme case of one engine failure on take-off for the Bristol Wayfarer machine—one of the modern types of civil transport to be standardised. Under civil regulations a twin-engined machine must be assumed to land at once under such conditions and the runway, from which it took off, must be long enough to permit of such landing in a straight line.



PLAN OF BELFAST HARBOUR AIRPOR

But it is also intended and work is already in hand with a view to extending a main runway within the next eighteen months to over **1,800** yds. In two years, not only will the main runway be able to reach **3,000** yds., but a new diagonal runway could be completed, **1,900** yds. in length. With such runway lengths, the airport would be, in the opinion of expert users " almost perfect " and entirely suitable for the operation of all types of civil aircraft used, or likely to be used, for internal services.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Impact Stresses on Jetties

Dear Sir,—

Referring to Mr. Minikin's letter which appeared in the February issue of your Journal, while I am sympathetic to his attempt to codify the problem of the impact stresses imposed upon a jetty or wharf by a colliding vessel, I do not consider that the procedure which he suggests is appropriate, because in the vast majority of cases the conditions of a ship coming alongside a jetty during normal berthing are not those of a collision. With tug assisted berthing, such as is the general practice in these docks, it is quite possible to achieve the ideal of bringing the vessel to an almost complete standstill before the moment of first contact with the jetty. Under these circumstances, no impact is developed.

For the purpose of designing against impact stresses, however, it is necessary to determine the incidence and extent of departures from this theoretical ideal. For this purpose a very large number of sets of observations would be required; in fact to carry out the procedure thoroughly, it would be necessary to observe every operation of berthing over a period of time sufficiently long to cover all conditions of weather under which berthing might be attempted. Even so, an exceptional run of good luck and freedom from potential accidents might render such a set of observations quite nugatory.

Assuming that a set of observations were to be obtained showing some degree of incidence of departures from the theoretical ideal of no impact during berthing, it would still be necessary to interpret these in the light of the relative economies of increasing the strength of marine structures to resist without damage a wider range of impacts—assuming that this can be done without increasing the damage to the vessel itself—and of accepting the risk of expenditure on repairs which would be involved with the weaker structure. For the above reasons, I do not consider that observations on a few isolated operations of berthing, as suggested by Mr. Minikin, would be of any value.

I suggest, however, that research into this problem might more profitably be conducted on the following lines:—

(a) By the analysis of a number of known cases of such damage to ascertain how far it might have been economically possible to reduce or eliminate the damage sustained, by increased strength in the original structure.

(b) By the examination of a number of typical structures where it is thought that unnecessary expenditure may have been incurred in the provision of excessive strength, to ascertain what reserve of strength against impact such structures contain, after all the normal stresses to which they are subject have been allowed for.

In this connection I would remind you that a vessel, having been berthed alongside a wharf or jetty, can very often remain there in safety during the development of weather conditions which might be too severe to attempt the operation of coming alongside. Under such conditions the structure might be fully stressed by forces arising from wind pressures,etc. The strength of such a structure would, therefore, contain a considerable reserve against impact under those conditions in which impact would be likely to be experienced.

As I understand it, the problem with which Mr. Minikin is dealing is not, primarily, the stresses that will be induced in a jetty structure by a horizontal blow whose value has got as far as being expressed as a given number of foot tons. Once the latter has been done, it appears to me to be fairly straightforward mathematics to estimate the deflection caused to, and the stresses induced in, the structure itself, although it will probably be necessary to make certain assumptions about the degree of end fixity, etc., of the members of the structure. It is the estimation of the amount of the blow which should be covered with which we have to deal at present, and it is in the procedure which Mr. Minikin suggests for making that estimation that I find matter for criticism. It is, after all, the limiting cases—which are of very infrequent occurrence as otherwise we should spend our time repairing jetties—that we wish to determine, and in the absence of a deliberate observation of every single operation of berthing over a considerable period of time, a series of isolated observations of berthing operations selected haphazardly at intervals might produce no results whatever.

I take it that there is no suggestion that we should complete one of the returns indicated by your Questionnaire only on occasions when a berthing operation causing some damage to a jetty has taken place. The necessary estimates of speed, angle of incidence and reflection, movement of jetty, etc., could, in such cases, only be obtained by the cross-examination of eye witnesses after the event, and everyone knows how unreliable such evidence can be.

Assuming then that a constant watch of all berthing operations, with specially appointed observers equipped to measure such things as speed of approach, etc., is the procedure Mr. Minikin has in mind, and apart from the fact that I doubt if any port authorities have the staff to spare for this at the moment, I find the method rather too empirical for my taste, as it involves the

Correspondence—*continued*

amassing of an enormous quantity of data, from which in the end, only a minute proportion will be sifted out as of any value. I therefore think we should attack the problem on rather more purely scientific lines, which I suggest is best done starting from the outer limits of the range of investigation which are, as I have indicated, respectively the jetty which is already known to have failed to some degree under certain circumstances and the jetty which is alleged to be over-designed. Finally, of course, one must reduce the whole matter to a basis of economics. It would be equally uneconomical either to design all jetties to resist blows of a weight which only one jetty in a hundred experiences over a period of years, or to cut down the design so that repairs would be necessary on every occasion of some slight maladroitness in the handling of the ship. The assessment of the economical strength of a jetty would appear to be a matter for collaboration between engineers and actuaries experienced in the assessment of marine risks.

There is the possibility that Mr. Minikin may intend in his observations to include the actual behaviour of the jetty structures under horizontal forces. If this is so, then I would most strongly urge that this should be tackled as an entirely separate problem. A suggested line of attack would be a series of experiments in which typical jetty structures, for which full design data could be made available, would be subjected to pre-determined horizontal forces and the deflection, etc., measured. I see no physical difficulty in this if the necessary resources are made available.

Static horizontal pressure, for example, could be exerted by a tug pushing under steady engine power through some form of buffer equipped with a dynamometer to measure the thrust transmitted. Calculable impacts could be arranged by allowing a vessel of known weight to collide with the jetty at a controlled speed and direction—in the interests of economy these collisions would have to be kept below the limit at which damage would be caused. Stress recorder readings on the various members of the jetty would be very valuable, and in the case of the impact experiments, the instruments used should be of the type that give a photographic record. Similarly it would probably be found necessary to take synchronised photographic records of the deflection and of the movement of the ship for these experiments.

It is appreciated that the course suggested is one which would involve a certain amount of financial expenditure, but it might possibly be thought a fit subject for a body similar to the Bridge Stress Committee which reported in the late 1920's.

Yours faithfully,

Docks Engineer's Office, J. H. JELLETT, M.Inst.C.E.
Southampton. 10th May, 1946.

To the Editor of "The Dock and Harbour Authority."

Harbour Models of Wave Distribution.

Dear Sir,—

I have read your Editorial Comment on "A South African Harbour Problem" which appeared in the May issue of *The Dock and Harbour Authority*, and as investigation of wave action by models is a subject occupying the attention of many Port Authorities at the present time, the following observations may be of interest:—

With regard to a harbour model, such as that for Cape Town, as an indicator of wave distribution, combination, and reduction, this method has been used with great success in other ports, of which Leith may be mentioned as an example, but modern practice is rather against exaggeration of the vertical scale in such models.

The waves in a harbour depend on several factors, of which the principal are the height and length of the open sea waves, the direction of wave approach, shore reflections, the width of the opening into the harbour, the orientation of that opening, the depths in the harbour and the position of the berths.

The periodic time and the direction of the waves are determined by the wind; the length in the open sea in deep water is also similarly fixed in relation to the periodic time, but in the shallower seas the velocity diminishes and with it the wave length, but the periodic time remains practically the same.

At an opening the wave will pass into the harbour with but little diminution if the effective width of the opening (i.e., square to the approach of the wave) is more than the wave length and only if it is less than that length does the wave spread out and diminish radially like the ripples about a stone dropped into a pond. Stevenson's well-known rule applies only to the latter type of wave reduction. Thus there is a practical dilemma. Wide openings required for big ships may not sufficiently scatter and thin-out waves of wave length less than the opening width no matter what their height. The critical widths are of the order of say 300-ft., but may be more, depending on the depths outside, and a model must take this into account.

In a model with exaggeration of slopes, such as the Cape Town one (the slopes were exaggerated 8.33 times) the waves are correspondingly distorted from the shape of those in nature and the frictional forces on the bed are reduced.

Doubtless general indications will be given by such a model as to the spread, diminution, reflection and interference of typical waves but some caution is required in accepting the results.

Small models, without exaggeration of slope, and using capillary ripples which can be seen or photographed by intermittent lighting may prove useful controls on the behaviour of large distorted models. Cape Town involves reflection and interference outside the actual basins and true similarity in the model is of great importance.

Yours faithfully,

Bath, Somerset. HERBERT CHATLEY, M.Inst.C.E.
18th May, 1946.

Dock Labour

Scheme for East Anglia

It has been announced that the Minister of Labour and National Service has approved a Dock Labour Scheme for East Anglia, under the powers vested in him by the Essential Work (Dock Labour) Order, 1943. The scheme, which came into force on April 29th last contains a number of changes compared with the Essential Work (Dock Labour) Order, 1941, and is the first prepared under the 1943 Order. An important change is contained in Section (f) of the principal objects of the scheme and reads: "To provide welfare services for port transport workers." This is a new feature and follows on the Essential Work (Dock Labour) (No. 2) Order, 1945, which makes the provision of welfare services a requirement of all future dock labour schemes. It is understood that all existing schemes will be amended to the same end.

The new scheme for East Anglia gives the National Dock Labour Corporation power for the first time to appoint Registration Committees. Hitherto, the Registration Committees have been responsible to the Ministry of Labour and National Service, and not to the Dock Labour Corporation. The Area Board will be responsible under the scheme for the grouping of all men in the Reserve Pool, a function previously carried out by the Registration Committee. At the same time, a worker is given power to appeal against his grouping, each local joint committee being empowered to appoint a panel of representatives nominated equally by the Port Transport employers and the unions, under an independent chairman, to hear such appeals.

The port areas covered by the scheme are:—

Boston.—The dock area and all discharging berths on the riverside between the Grand Sluice and Maud Forster Sluice.

Great Yarmouth.—All quays, wharves and warehouses adjoining both sides of the river from the Haven entrance to Breydon Swing Bridge and to Vauxhall Bridge.

King's Lynn.—The dock area and riverside quays and warehouses up to and including the sugar beet factory.

Lowestoft.—All quays, wharves and warehouses within the confines of the dock area, including Oulton Broads.

Sutton Bridge and Wisbech.

Trade at South Wales Ports

Excerpts from Report and Recommendations of the General Cargo Sub-Committee of the South Wales and Monmouthshire Joint Ports Committee

Terms of Reference

A Minute of the first meeting of the South Wales and Monmouthshire Joint Ports Committee, held on 7th January, 1946, defined the aims of that Committee in the following terms:—

"To promote the prosperity of the South Wales and Monmouthshire Ports by taking joint action in matters concerning their welfare.

At the first meeting of this sub-committee, held on the 11th January, 1946, it was unanimously agreed its terms of reference should read:—

"To set out the facts militating against the objects of the Joint Ports Committee and to suggest remedies."

Membership of Sub-Committee

The sub-committee were fortunate in that its membership included representatives of the several commercial interests involved in the problem. Its constitution was as follows:—

Shipowners.
Shipbrokers and Liner Agents.
Shipping and Forwarding Agents.
Port Authority.
Railway Company.

Additionally, several of the sub-committee meetings were attended by the Regional Export Officer, Board of Trade.

Recapitulation of Problem

Although primarily all the ports on the north shore of the Bristol Channel (referred to hereafter as the South Wales Ports) owe their modern development to the shipment of coal, their prosperity has been almost equally dependent upon the large tonnage of raw materials and semi-manufactured goods needed for or produced by local industry, e.g., iron and other ores, steel billets, ingots, bars, etc., tinplates, galvanised sheets, non-ferrous metals, timber, grain, etc.

For many years the export of coal has dwindled until from their peak of nearly 40,000,000 tons in one year, the South Wales Ports in 1945 dealt with only 5,000,000 tons.

Simultaneously, international unrest, tariff restrictions, political boycotts, currency difficulties and cartel arrangements, culminating in the dislocation caused by the war, have all played their part in reducing the volume of local works imports and exports, so that the ports are now faced with the problem of continued existence upon a total trade of some 10-12,000,000 tons per annum instead of the 45-50,000,000 tons which they have handled in the past.

The trade of the six principal South Wales Ports, i.e., Newport, Cardiff, Penarth, Barry, Port Talbot and Swansea, before, during and since the war is well illustrated by the following tables; although the year 1937 is far below the peak figures which were reached in earlier years:

Exports (in tons)

	Coal	Oil	Tinplates	General Cargo	Ballast	Total
1937	21,556,406	193,751	507,483	596,486	2,200	22,856,326
1943	7,868,533	536,030	30,252	1,088,097	413,434	9,936,346
1945	5,144,650	611,217	36,928	1,675,971	888,810	8,357,576

Imports (in tons)

	Iron and Steel	Timber etc.	Ores	Oil	General Cargo	Total
1937	761,670	1,115,123	1,366,433	573,448	1,015,487	4,832,161
1943	738,822	134,224	482,057	1,405,132	2,505,902	5,266,137
1945	139,061	347,189	1,000,403	860,535	1,392,289	3,739,477

Comparison of Total Tonnage

1937	... ...	27,688,487
1945	... ...	12,097,053
	Decrease	15,591,434

The foregoing statistics are illuminating in many respects, but there are two particular features which the sub-committee wish to bring into prominence in this report, viz.: the quantum of traffic dealt with other than coal, both before and during the war, and the growth of the general cargo trade during the war years.

Excluding also oil, as being a highly specialised trade normally dealt with elsewhere than at the cargo quays and ballast, which merely reflects the abnormal conditions of the war period, the following figures are of outstanding interest:—

Total Cargo, Excluding Coal, Oil and Ballast (in tons)

		Exports	Imports	Total
1937	...	1,103,969	4,258,713	5,363,682
1943	...	1,118,349	3,861,005	4,979,354
1945	...	1,712,899	2,878,942	4,591,841

During the war years, the export of tinplates was reduced to almost negligible proportions whilst the imports of timber, ores, etc., were also much restricted. These losses were more than offset by the vast tonnage of war stores and equipment, and the additional imports of food and other commodities, hence the increase shown in the following table:—

General Cargo (in tons)

		1937	1943	1945
Imports	...	1,015,487	2,505,902	1,392,289
Exports	...	596,486	1,088,097	1,675,971
	Totals	1,611,973	3,593,999	3,068,260

One of the objects of stressing the large tonnage of goods other than coal which has always been dealt with at the South Wales Ports, is to correct a current misapprehension that, in representing their case, the ports are asking merely for a continuance or extension of trade which came to them as a result of war-time restrictions on the use of other ports. This is not so. The South Wales Ports have always had an appreciable general cargo trade in normal times, both in imports and exports, their export trade from local works prior to the war having been sufficient to attract most of the regular general cargo liner services.

During the war, the ports were called upon to deal with practically every commodity required to equip and maintain the Armed Forces and at the same time to meet the needs of the nation. Simultaneously, they continued as far as possible to deal with normal traffics. To meet these exceptional demands new quays were built and equipped, additional transit sheds provided, and rail accommodation and access augmented and improved. All these additional or improved facilities remain available and ready to deal with a fair share of the increased shipment tonnage which must ensue if the national programme to increase exports to 75% above the 1938 totals is achieved.

The activities of the South Wales Ports during the war proved their ability not only to deal with any class of goods up to the maximum of their berth capacity, but that, with proper co-ordination of transport, i.e., rail, road and coastal shipping, no difficulties of collection and/or distribution need be anticipated.

For the present, the end of war activities has thrown the South Wales Ports back to dependence largely on local industries, which, as a result of the war, are not yet able to recover their peace-time trades. Some have been made redundant and most are short of both labour and materials.

New factories and new plants will take a considerable time to get into full production, possibly two or three years or even longer. Furthermore, there appears to be no possibility of an early improvement in the export of coal or even of any appreciable increase in coal production, thus, not only are the ports short of some 15,000,000 tons of export business, but the low level of coal production re-acts directly and unfavourably on the imports of pitwood, timber and other mining equipment.

Trade at South Wales Ports—continued

Such curtailment of normal activities must inevitably cause acute unemployment both at the docks and in the many ancilliary businesses which depend upon them. This is already evident in the March, 1946 Register of Unemployment, in which South Wales appears as the "blackest" spot.

The Problem Analysed

At their first meeting, the sub-committee reached the conslusion that the problem necessitated careful analysis and exploration, but that it fell naturally under two main headings, namely, "Short Term Policy" and "Long Term Policy."

The "Short Term Policy" must bring relief in the period which must elapse before any benefits to the trade of the South Wales Ports can be expected from the implementation of the "Long Term Policy" and bridge the gap between war and peace-time activity.

The "Long Term Policy" must be designed to place the South Wales Ports permanently in possession of the trade to which their status amongst British ports and their geographical position entitles them. It necessarily entails change in old-established practices and complete success will not be easily or immediately achieved.

It is under these two main headings, therefore, that this report has been compiled.

Short Term Policy Recommendations

1. Welsh Members of Parliament should be kept fully informed and encouraged to press the case of the South Wales Ports in the House at every opportunity and by all means possible. Also that the Joint Committee should request the Members of Parliament to provide assistance regarding the proper approach to the various ministries.

2. The direct approaches should be made by the Joint Ports Committee to the executive heads of commodity controls at the Ministry of Supply and Food with the object of persuading them to direct more Government controlled goods to the South Wales Ports. Particular stress should be laid on the ports ability to serve economically and efficiently a much wider area than South Wales and Monmouthshire alone.

3. Direct representations should be made to the appropriate department of the Army, Navy and Air Force to secure shipment through the South Wales Ports of as much as possible of the vast quantities of stores and materials needed for the armies of occupation, and surplus stores and equipment, including scrap materials being returned to this country.

Long Term Policy

(a) **Increasing Exports.**

The recommendations in regard to this are summarised as follows:—

1. Local manufacturers and exporters should be requested to stipulate shipment at South Wales Ports whenever possible.

2. The "Clearing House" should be established as quickly as possible.

3. Shipowners should be approached to resume their pre-war arrangements for loading out of South Wales Ports wherever this has not already been done and to institute new services as and when traffic is deemed to offer sufficient inducement.

4. Local works should be asked to co-operate by advising the committee as early as possible whenever they are instructed to ship large blocks of traffic elsewhere than at a South Wales port. Representations can then be made to the Liner Conference concerned and to the Ministry of Transport.

(b) **Widening the Area which can be Economically served by South Wales Ports.**

In the opinion of the sub-committee the main weight of any case put forward with the object of increasing the flow of trade through the South Wales Ports falls under this heading.

Although the ports, in large measure, owe their origin to export coal, their construction makes it clearly evident that their original owners had every intention that the ports should be equally capable of dealing with general cargo. At each of the ports approximately half the lay-out is devoted to coal shipping, the other half being equipped with transit sheds, cranes, etc., to deal with general goods. Past prosperity in South Wales tended to relegate to second place any early schemes for widening the territory served. Traffic arising from local industry was the first concern. Nevertheless, some of the then owners of the docks regularly advertised their particular ports with the object of encouraging trade with the Midlands. These efforts met with some small measure of success, but only in certain restricted fields.

Prior to the outbreak of war, it must therefore be admitted that the proportion of traffic passing through the ports other than that arising locally was almost negligible.

During the war, that position underwent a vast change and it is fortunate for the nation that the ports, despite years of trade depression were modernised and kept efficient in their facilities and equipment to such a high degree that they were capable, with comparatively little addition, of meeting all the demands made upon them.

As previously stated, the ability of the South Wales Ports to deal with miscellaneous general cargo is proved by their record. A comparison of relative distances shows that geographically, they are at no serious disadvantage in competing for Midlands traffic. Yet it has not hitherto been possible for the ports to take what would appear to be their natural competitive position.

In the view of this sub-committee, the reasons for this are directly attributable to:—

i. Port Charges.
ii. Railway Rates and arrangements.
iii. Ocean Services.
iv. Merchants and shipowners prejudices.

i. **Port Charges.**

It is commonly accepted by most of those engaged in shipping and export trades that the application of port charges at British ports is chaotic—port practices in relation to the division of charges between the respective interests varying, in some degree, at most ports.

The major trouble lies not so much in the total costs of loading general goods at the ports, but in the division of those charges.

The services involved in conveying shipment goods from, say, Birmingham to ships' rail at any port are, firstly, the haulage rate, rail or road; secondly, off-loading the wagon to dockside shed; thirdly, laying out in the required order on the shed floor; fourthly, transferring the goods when ready for shipment to the face of the shed where they are slung and transferred by crane to ships rail.

At the South Wales ports, with one or two minor exceptions, the whole of the cost of such services has to be borne by the shipper or the exporter. At most other ports dealing with general cargo throughout the country, the shipper is relieved of the charges for labourage services at the port in varying measure.

Methods by which shippers are relieved of port costs at the various ports fall mainly under two heads. Namely, by the practice of the railway companies of giving rebates and/or allowances from railway rates and by the shipowner accepting the costs of certain services as a charge against freight. Typical examples are the ports of London and Liverpool where in the case of the former, the railway companies out of "delivered" railway rates on traffic from certain zones, pays to the P.L.A. an amount intended to reimburse the Authority for their services from dock junction to receipt into shed and subsequently handing to the ship at shed door, the shipowner in most cases taking responsibility for charges from that point. At Liverpool, the shipowner takes responsibility for costs from the point at which the goods are off-loaded from vehicle at the back of the shed, whilst in addition on truck hauled traffic, the railway company give certain rebates which largely off-set the amount which the shipper has to pay for haulage from dock junction to ship's side or shed and for unloading from truck to shed.

Even in those cases where goods are of a character which do not require being shedded before shipment, much the same con-

Trade at South Wales Ports—continued

ditions exist. For instance, both at Liverpool and London and many other ports in the country, the shipowner takes responsibility for costs of slinging from the point at which the goods are placed alongside the ship.

Having regard to the differing practices at the general cargo ports, it was decided that rather than take any one port as being a criterion of the fairest method of division between the various interests, the sub-committee would itself suggest what was in its opinion the most equitable division. This is as follows:—

Traffic Shipped Through Shed.

Carriage Rates which are Inclusive of Delivery.

(a) Carrier pays half costs of unloading from truck to pile on the assumption that it is fair that he should be responsible for putting the goods under shed roof in the handiest place available, i.e., without regard to the additional handling, wheeling, etc., which is necessarily involved in laying the goods out in the Port Order, etc., for ship's stowage purposes.

(b) The shipowner pays the other half of the cost of putting into shed because it is his requirements which involve slowing up of the straight shed processing owing to his need for checking shipment marks, serial numbers and piling in Port Order, separating dirty stowage, etc. He also pays the full cost of taking out of shed and slinging for shipment, as it is considered that when the goods have been placed directly under his charge on the shed floor, it is his responsibility to take aboard and stow as necessitated by the ship's requirements.

(c) The shipper pays the port due on the goods, i.e., "Dock Dues on Goods (Wharfage)" as it is known at the South Wales Ports, although, of course, he has already paid additionally the proportion of the shed costs as carriers liability inasmuch as he has paid a "delivered" rate to the carrier.

Goods Not Inclusive of "Delivered" Conditions.

(a) Shipper would have to pay half the costs of unloading from vehicle to shed pile instead of the carrier, plus the due on the goods (wharfage).

(b) The shipowner would pay precisely the same irrespective of whether goods were carried with "delivered" conditions or not.

Traffic Shipped Direct ex Truck.

(a) Irrespective of conditions of carriage, the shipowners to pay the cost of shipping ex truck once the goods have been placed under the plumb of his cranes or derricks, as well as the stowage costs.

(b) The shipper to pay only the Dock Rate on Goods (Wharfage).

Recommendations

Shipowners should be approached through the appropriate channels to afford South Wales Ports similar facilities for the shipment of general cargo to those available at other ports. It is considered to be essential that shipowners accept as a charge against freight, costs of dock labourage services in accordance with the division between the interested parties suggested in the foregoing.

ii. **Railway Rates.**

A summary of the recommendations regarding this matter is as follows:—

(1) Manufacturers, merchants, shipping and forwarding agents, etc., should be encouraged to advise the sub-committee of all rates known to them which appear adversely to affect the competitive position of the South Wales Ports.

(2) The committee should list such rates for regular submission to the Great Western Railway with a view to seeking implementation of that company's promise to examine and adjust such rates wherever possible.

(3) The Great Western Railway should be requested to introduce an arrangement whereby shippers will be relieved of at least a proportion of dock labourage costs. The minimum assistance considered acceptable for this purpose would be that the railway company should make itself responsible for unloading railway wagons at the docks, either to shed floor or direct to ship in all cases where they collect "delivered" rates.

(4) The Great Western Railway should be asked to extend to Swansea and Port Talbot the principle in force at all other South Wales Ports under which town rates are equally applicable to the docks. This will relieve the shipper of the necessity of having to pay the dock haulage rate in addition to the railway rate.

(5) Application should be made to the railway companies to consider the practicability of railway rates to the South Wales Ports (Newport to Swansea inclusive) from within a radius of 25 miles of Birmingham being made in no case higher than rates for the same commodities for shipment through any other port. Traffic emanating elsewhere than in the Birmingham area shall not be rated higher on a mile for mile basis to those individual South Wales Ports than it might be to any other port.

iii. **Ocean Services.**

As already stated, the many Liner services operating out of the South Wales Ports, prior to the outbreak of war, called primarily for the purpose of loading tinplates and other heavy steel products of local works. Comparatively small quantities of lighter general cargo from other parts of the country were also loaded if and when they offered, but in practically all cases the Liners, after taking bottom cargo from South Wales, sailed to other ports such as London and Liverpool for completion of cargo before proceeding overseas. The proportion of true general cargo in relation to the total tonnage shipped through the South Wales Ports was exceedingly small.

Most of the Liner Conferences were represented in the list of Liner sailings from the ports, and the sub-committee were gratified to find that prior to the war such world-wide sailings were available. Nevertheless, the fact that these calls were entirely dependent upon local works products and fluctuated in frequency with the availability or otherwise of local traffic, emphasises the scope for improvement that exists.

During the war, Liner-class tonnage was efficiently and expeditiously loaded with complete cargoes of miscellaneous goods drawn from all over Great Britain and the ports are equally, if not more, capable of loading complete cargoes now than they were during war-time conditions.

The sub-committee appreciate that under ordinary commercial arrangements cargo must in the main be drawn from within reasonably economic limits. If, however, the South Wales Ports gain the equality of treatment in relation to the division of ports costs and railway rates which they are seeking, the sub-committee are convinced that sufficient true general cargo is available within a widened area, particularly in and around the Midlands, to provide full cargoes instead of merely the "bottom" cargo dealt with hitherto.

Every possible effort should be made to get Liner companies not only to resume their pre-war services, but to institute new services, immediately sufficient goods are available for either full or part cargoes and to load at the South Wales Ports all the general cargo available.

iv. **Shipowners' and Merchants' Prejudices.**

The sub-committee, recognising that certain prejudices might exist which, if not removed, could operate to the detriment of the extension of trade to the South Wales ports made an examination of those brought to their notice.

While it appears to be generally conceded that accommodation, facilities and equipment of the South Wales Ports compare favourably with those of any port in the country, additions to transit shed accommodation at some of the ports is considered necessary, and the sub-committee were assured that improvements

Trade at South Wales Ports—continued

in this regard are already contemplated and will be provided by the Port Authority as soon as circumstances permit. Additional mechanical equipment for facilitating shed work, etc., will, the sub-committee were informed, be provided whenever the need manifests itself.

One of the criticisms levelled against the South Wales Ports was the present inability to get cargo workers to work reasonable overtime. This is a matter which has only recently arisen, and is the direct outcome of the almost continuous overtime working which took place throughout the war. It is at present the subject of discussion between the employers and the men, through the appropriate negotiating machinery, and it is confidently expected that a suitable overtime agreement will be reached shortly.

The appropriation of berths to particular Liner companies' sailings was also considered, and whilst pointing out that the number of Liner berths available at some of the ports limited the extent to which this principle could be employed, the Port Authority gave an assurance that, measured entirely upon the regularity of the service concerned, they would be prepared to consider sympathetically any application from Liner owners or conferences for preference berth facilities to be provided.

Such prejudices as those arising from the fact that shipowners' main organisations are based on their principal home ports, from the differing practices in relation to the point at which shipowners take responsibility for goods, and from alleged inexperience of handling certain classes of general cargo, were all considered by the sub-committee to be of a character which would provide their own remedies with the growth of the general cargo trade through the ports.

As far as merchants' prejudices are concerned, these appear to be mainly connected with costs, and if the South Wales Ports could be put into a position in this regard which is comparable with other general cargo ports of the country, shippers, manufacturers, and merchants would have no reason to discriminate against the shipment of general cargo goods through South Wales Ports, provided sufficient Liner services are available.

The sub-committee strongly recommends, however, that every endeavour should be made by the Port Authority to publish schedules of port dues on goods, and charges for labourage services payable by shippers and merchants, but recognises that to do so until the question of the proper division of such labourage costs between the various interests has been resolved, would be of little if any value.

Resumption and Extension of Import Traffic.

The section of this report entitled "Widening the Area which can be economically served," applies almost equally to the question of increasing the tonnage of imports through the ports as it does to exports. In some measure, the problem in relation to imports should be easier, inasmuch as the line of demarcation as to responsibility for payment of charges by interests concerned, is more clearly defined in the import trade than it is in relation to exports. Thus the problem rising out of special concessionary arrangements, rebates from railway rates, etc., does not offer the same difficulty.

One essential for the extension of the area served by South Wales Ports with imported traffics is, however, the availability of railway rates which are comparable with those in existence from other ports to such areas as the Midlands, and no opportunity should be lost of bringing to the notice of the railway companies any instances where "special" rates in force from ports within competitive distance are more favourable than those on the same commodities from the South Wales Ports.

The sub-committee viewed with concern information put before them regarding the number of vessels which discharge at other ports, large quantities of cargo destined for South Wales, and territories well within the influence of the South Wales Ports, or which, after discharging their main cargoes at other ports were sent to South Wales with nothing other than heavy bottom cargo such as steel, zinc concentrates, etc., although in many instances the South Wales Ports could have dealt with practically the whole cargo and distributed it economically to eventual distinations.

As long as food rationing and commodity controls remain, the Ministries of Food and Supply could, in the view of the sub-committee, show more interest in the current position of the South Wales Ports by using their directive powers to see that suitable cargoes of this nature are directed to discharge at the ports. In this connection it is pertinent to draw attention to the congestion which it is apparent exists at both London and Liverpool at the present time, and to point out the absurdity of vessels having to wait turn for suitable berths at those ports whilst idle berths and men are available at South Wales. The sub-committee recommend that the appropriate Ministries should be pressed to put as much cargo as possible through the South Wales Ports, bearing in mind that even in those cases where goods might be destined for places outside the truly economic area served by the South Wales Ports, no additional expense would appear to be involved having regard to the flat rate arrangements under which the Government goods are carried by railway companies.

Summary of Recommendations

To summarise, the sub-committee recommends that:—

(1) Full co-operation should be maintained with the Welsh Parliamentary Party.

(2) The Government should be asked to direct a fair share of the cargo which they control to the South Wales Ports. Emphasis should be laid on the widening of the area economically served by these ports.

(3) Co-operation should be offered in any measure designed to improve the present position of the South Wales coal export trade.

(4) Local exporters should stipulate shipment at South Wales Ports wherever possible.

(5) The Clearing House should be established as quickly as possible.

(6) Shipowners should be approached to resume pre-war sailings and institute new services where necessary.

(7) The committee should be informed when local firms are instructed to ship large blocks of traffic elsewhere than at South Wales Ports.

(8) There should be a change in the division of port charges at the South Wales Ports. Shipowners should be approached to treat South Wales Ports in the same way as other ports and accept as a charge against freight, costs of dock labourage services in accordance with the division suggested.

(9) Exporters should inform the committee of unfavourable rail rates for South Wales Ports. Such information should be made the subject of representations to the railway company.

(10) The railway company should also be asked to relieve shippers of at least a proportion of dock labourage charges.

(11) The railway company should be asked to extend to Swansea and Port Talbot the principle that "town" rates are equally applicable to the docks.

(12) The railway company should be asked to accept the suggested system of rating for traffic from the Midlands to South Wales Ports.

Census of European Small Craft.

The European Central Inland Tranport Organisation has recommended to the Governments and the Occupation Authorities that a census of all inland waterway and harbour craft in Continental Europe should be taken on Thursday, August 15th. The object is to determine the losses incurred; to obtain an overall picture of the inland water transport situation; to trace Allied and neutral craft displaced by the events of war and to suggest suitable types of ex-enemy transport material for selection by the appropriate authorities as partial replacement of Allied losses. Each government and authority will be responsible for the procedure within its own territory.

Twenty-five Years Operating Experience with the Argentine Dredger No. 214 C*

By EMILIO MALLOL, C.A.I.

In 1920 the Riachuelo Workshops of the Argentine Ministry of Public Works put forward the proposal for the construction of a "suction dredger with cutting equipment" designed for dredging and making embankments simultaneously in calm

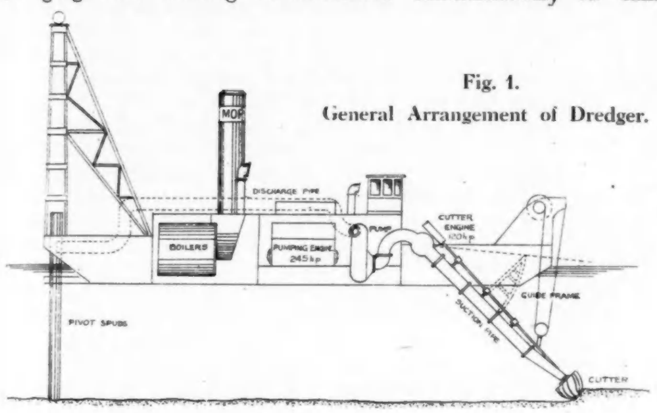


Fig. 1.
General Arrangement of Dredger.

waters and at shallow depths; its small draft was to enable it to operate in the mouths of our great rivers, and especially in muddy deltas, being able to open channels 8.50 metres deep and 40 metres wide in a single run. The provision of floating tubing supported on special pontoons enables embankments to be formed economically.

With the sole exception of the main engine, taken from the dredger "16 C," all the machinery for this vessel was built in the Ministry's Workshops. Fig. 1 shows a longitudinal section of the dredger; an important feature is the closed type cutter, which covers the mouth of the suction tube and thus provides protection against large bodies or other material entering the pump. The cutter is formed of a number of detachable knives, the shape of which has been determined by experiment in each particular case, and these rotate slowly; a special type of steam engine is used for turning the cutter, capable of providing a maximum output of 120 horse power. It is fitted as an integral part of the suction tube, and drives the cutter through a reduction gear. Other features are the crane in the bow for lifting and

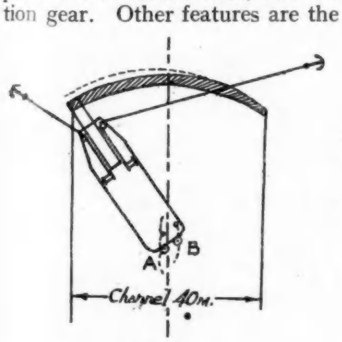


Fig. 2.

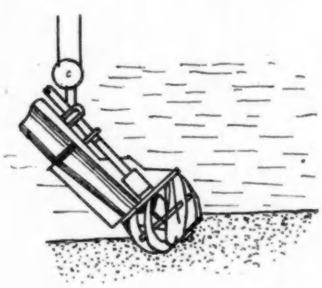


Fig. 3.

lowering the suction tube, and the spherical joint which allows the suction tube to be operated at the maximum depth of 8.50 metres, the entry of air being prevented by a combination of forced lubrication and water under pressure, thereby providing a true liquid packing; and the elastic anchorage of the suction tube to the forward bulkhead.

The main engine of the dredger develops 245 horse power at a speed of 140 r.p.m., steam being supplied by two marine boilers fired by oil, enough fuel being carried on the vessel to allow for a voyage of twelve days. Electric light is provided for night work and there is a complete service of running water. Forced lubrication to the bearings of the cutter driving shaft enables the vessel to continue working at full output, and there is an automatic indicator giving the depth of dredging; a safety chain is provided in case the suspension system of the suction tube should carry away. The winches for hauling the dredger ahead and for raising and lowering the pivot spuds at the stern are operated by electricity.

The method of operation of this dredger can be understood by reference to Fig. 2, which indicates the cutting of a channel 40 metres wide; the paths of the cutter and of the pivot piles are indicated clearly. The spuds A and B are driven alternately, thereby forming pivot points around which the vessel rotates when cutting; it is claimed that this method of working is better than other existing means. Every item has been designed in such a manner that the possibility of breakage is equal in each case; the power of the machinery is such that it will stall automatically when an obstruction is encountered and resume work as soon as the resistance becomes easier or has dispersed; the scantlings of the vessel conform to the rules laid down by the Bureau Veritas, 1918.

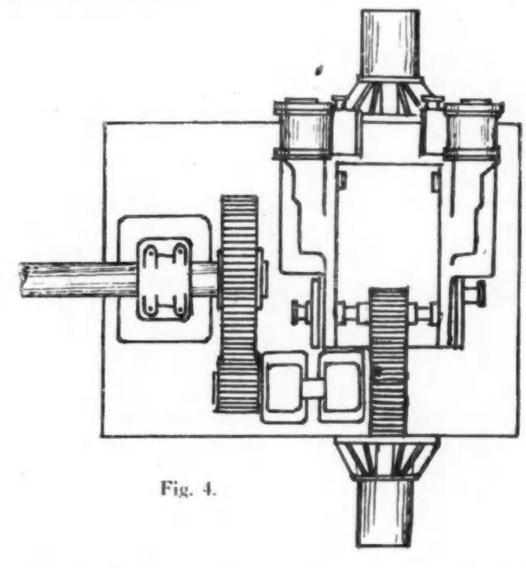


Fig. 4.

The hull is in the form of a box with a rectangular cross section; in the bow is the suction tube and cutter mechanism, and at the stern are the two towers upon which are mounted the pivot spuds. Amidships are the main and auxiliary engine rooms, boilers, dredging pump and oil tanks; the discharge pipe from the dredging pump runs along the top of the engine room fiddley and finishes in a spherical joint between the two spud towers, almost at water level, thus facilitating the discharge of the dredged material either in a channel or through a floating pipe line, in which case it is possible to carry out the operations of dredging and forming an embankment simultaneously. The leading dimensions of the hull are: length 30.00 metres, beam 9.00 metres, draught 2.76 metres; displacement 370 tons.

The object of the cutter is to increase the density of the material at the mouth of the suction tube, and we have adopted the closed type (Fig. 3) with cutting knives of simple form and constant thickness, easily replaceable, mounted on a central shaft of cast steel at the front end and upon a steel ring at the rear; its normal speed of operation is 20 r.p.m., variable within certain limits by the cut-off of the engine. The latter is of the two-cylinder type and is shown in Fig. 4; it has a free exhaust and the cranks are set at right angles to one another. It is fitted with Stephenson link motion and drives the cutter through a train of gears; the gross power developed by the engine at a speed of 225 r.p.m. is

*Abridged translation from the report published in the October, 1945, issue of "La Ingenieria," by Rolt Hammond, A.C.G.I., A.M.I.C.E.

Twenty-five Years Operating Experience wiih Argentine Dredger—continued

90 horse power, and as the overall efficiency of the gearing is about 50 per cent., the power available at the cutter is about 45 horse power. The driving shaft has been designed to resist combined compression torsion and bending; the maximum permissible stress is 825 kgs. per square centimetre under the assumed action of a frontal shock of 100 metric tons and a lateral thrust in the centre of the cutter of 5 tons when the full

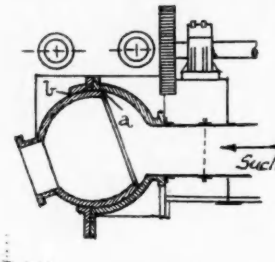


Fig. 5.

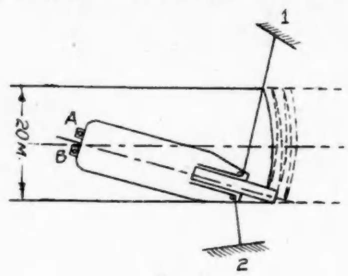


Fig. 6.

120 horse power is operating. The cutting mechanism is supported by a series of bearings and has two three-ring thrust bearings which work below water; all bearings are provided with forced lubrication.

The suction tube, of 60 centimetres diameter, is so mounted that it cannot transmit any force to the spherical joint. The mechanism for hoisting and lowering the suction tube assembly comprises a two-cylinder steam engine driving twin winches through worm and pinion gear, the complete manœuvre between extreme positions taking about eight minutes; a safety chain with a powerful spring has been provided to hold the suction tube assembly in the event of the suspension system being broken. This safety device is augmented by a device for fixing the assembly in any required position for the purpose of carrying out maintenance and repairs. The suction tube assembly is provided with a curved guide frame (visible in Fig. 1) which prevents any side thrust being imposed on the suspension bearings.

The most delicate part of the vessel is the spherical joint for the suction tube, shown in section in Fig. 5; not only was this difficult to manufacture, but it had to be mounted in such a manner as to satisfy certain special conditions; moreover, the joint had to be effectively sealed against entry of the atmosphere, which would prevent the plant from operating; and the flange had to be maintained in exact relationship to the inner spherical portion. The joint was made in two halves, with the idea of facilitating its erection; three semi-circular grooves have been provided in the flange ring into which water under pressure is injected by a small automatic feed pump; thus a series of liquid rings are provided which hinder the entry of air. Lubricating grease was also injected into the centre of the joint. This device was described as " interesting and courageous " by Rear Admiral Evans Thomas, who commanded the battle cruiser squadron at

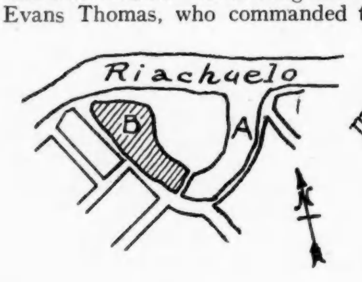


Fig. 7.

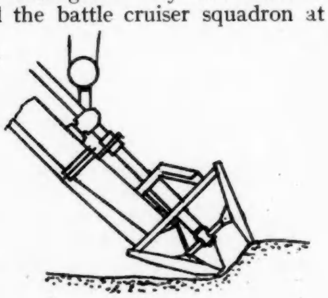


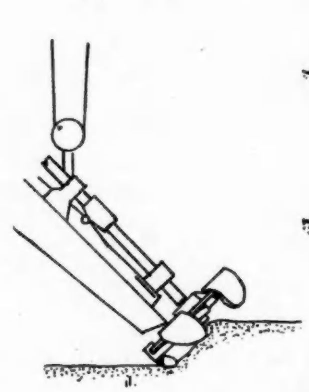
Fig. 8.

Jutland, when he visited the Riachuelo works as a member of a commercial delegation after the conclusion of the Treaty of Versailles and saw the " 214 C " under construction.

In writing of this apparatus 25 years ago, we said: " We are quite satisfied with the effectiveness of the water seal in the grooves of 5 mms. diameter, although we have no available precedent; if tests are not satisfactory, the development of this joint will be difficult. It should be noted that the spherical joints of floating pipe lines, due to the fact that there is internal pressure, have an inherent tendency to seal hermetically the surfaces in contact adjusting themselves automatically. We have complete confidence in the forced circulation of water." Under the worst conditions the water encounters less resistance in issuing from the flange ring *b* than in entering the inside of the joint through the portion *a*; thus, if the output of the pump is increased until the injection water flows to the outside across the whole section as at *b*, it seems to us that it will be very difficult for air to enter through the same passage." Later experience confirmed our hopes, and after all this time the original joint continues to give satisfactory service.

The main pumping engine is a triple-expansion condensing unit, with cranks set at 120 degrees, developing 235 indicated horse power at a speed of 132 r.p.m. Assuming an efficiency of 77 per cent., the effective power developed is 235 x 0.77, equals about 180 horse power, giving a discharge of about 500 cubic metres per hour from the pump of liquid with a fluid density of 1.5 kgs. per cubic decimetre.

Under working conditions the cutter describes a curved path and forward movement of the dredger is effected by means of a pair of spuds at the stern which are used alternately as pivots about which the vessel turns under the pull of one of the forward winches. Fig. 6 shows the paths described by the cutter and



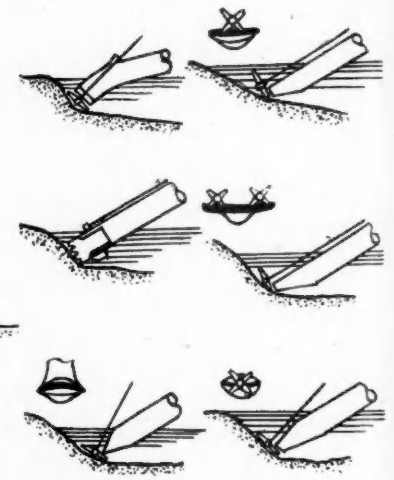


Fig. 9.
Fig. 10 (left).

illustrates the fact that the minimum width of channel which can be excavated is 20 metres and the maximum 40 metres. The pivot spuds have been arranged outside the vessel, in order that a false manœuvre will not endanger stability; the spuds are guided by hardwood fenders with the large play of 10 centimetres. Before the suction tube can be damaged by bad handling when lowered to its maximum depth, the following events may take place: (1) breakage of the hauling cable; (2) breakage of the teeth of the pinion on the forward winch; (3) automatic stoppage of the winch, due to its limited power.

The two marine boilers are of the return tube type, designed for a working pressure of 12 atmospheres; the total heating surface is 82 square metres and 4,600 kgs. of steam per hour are produced, a quantity sufficient to meet all demands. The oil firing system is of the direct type and enough storage of oil and lubricant is provided for a working trip of twelve days. The complete boiler installation, comprising water level indicators, safety valves, feed pumps, injectors and so forth, were made in the Riachuelo workshops.

On the 10th November, 1922, after 18 months' work, the dredger was finished, the first vessel of this type to be built in South America; our " maritime conscience " was born from that moment and we began once again to think of our coasts and rivers. In 1923 a test was carried out at Puente Alsina dredging the centre and left bank of the Riachuelo, working for nine hours

Twenty-five Years Operating Experience with Argentine Dredger—continued

a day at a cost of 399 paper pesos; the official report states: "each cubic metre dredged to a depth of 5.50 metres pumped through a floating pipe line 116 metres long with a difference in level of 9.50 metres, cost 18 centavos, taking into account only the embankment; the overall cost, including that of the material dredged, was 30 centavos per cubic metre." At the beginning of 1924 dredging was carried out on the left bank of the Riachuelo, when some 10,000 cubic metres of embankment was deposited at a distance of 200 metres from the dredger, partly through a floating pipe line and partly through a pipe line laid on the ground.

Later, dredging of a part of the old bed of the Riachuelo was undertaken to a depth of 3.65 metres below datum, as shown in Fig. 7; the dredged material was filled into zone B over an area of 24,000 square metres and to a height of 2.60 metres above datum. This operation last 40 days, the National Exchequer benefiting to the extent of more than a million paper pesos.

In 1924 various designs of cutter for the suction tube were tried out, one of them being a four-bladed propeller; this was not protected in the same manner as the closed type of cutter and it was necessary to employ curved protection plates, thereby reducing dredging efficiency. Scrap iron, chains, timber beams and stones were drawn into the pump and caused serious damage. Often it was necessary to raise the suction tube as many as seven times an hour in order to clear the mouth of a large quantity of scrap iron, stone, chains and sleepers.

Generally speaking, the propeller type of cutter was inefficient, and we therefore designed a cutter with three tangential blades having sharp edges, which gave excellent results in loose soil; this is shown in Fig. 8. For working in ground of medium hardness, we found that the cutter with sharp concave blades shown in Fig. 9 gave good results.

For economic reasons a three-armed cutter was employed, the knives being set to a wide angle in order to open up the ground to the necessary width for the suction tube to be moved without any lateral force being imposed upon it.

The trials proved to our satisfaction that it is a great advantage to reduce the diameter of the cutter as much as possible, adopting mouths for the suction tube of the different forms shown in Fig. 10; these cutters rotate at the slow speed of between 15 and 25 r.p.m., because it is inconvenient to disperse the solid material and we thereby reduce considerably the power required to remove the dredged material.

In 1927 this dredger carried out work at Puerto Briand, where in 10,000 hours of effective operation it excavated about 1,500,000 cubic metres of solid material.

Hobart, Tasmania

Excerpts from the Annual Report of the Marine Board for the Year ended 31st October, 1945

Trade of the Port

Although the inward cargo showed a decline of over 10,000 tons compared with the previous twelve months the outward cargo was slightly greater.

Cargo

	Inward 1943-44 Tons	Inward 1944-45 Tons	Outward 1943-44 Tons	Outward 1944-45 Tons
Ocean Pier	57,391	47,826	42,060	71,039
Queen's Pier ...	16,847	6,821	17,527	70,954
King's Pier	23,162	21,293	79,107	32,033
Elizabeth Street Pier	20,648	44,658	43,999	19,473
Macquarie Wharf ...	41,518	26,900	—	—
Prince's Wharf ...	75,441	77,288	80,772	70,625
	235,007	224,786	263,465	264,124

Financial

Owing to the continuous falling off of revenue since the outbreak of the war, the Board found it necessary to abolish the 20 per cent. reduction which it had been allowing (10 per cent. since 1935 and 20 per cent. since 1937) on wharfage rates.

Since the reductions were allowed, it has meant a loss of revenue to the Board of over £68,000.

It is now expected that as soon as shipping becomes available the trade of the Port will gradually return to pre-war level, but with the new works which must be undertaken within the next few years, the Board's interest charges on borrowed moneys will be heavy.

Receipts from wharfage rates for the past financial year showed a further decrease, and the amount collected was approximately 23 per cent. below the 1938-39 figures.

Total Ordinary Receipts were £39,109, as compared with £45,927 for 1943-44, and £42,478 for 1942-43.

Shipping

A big drop is recorded in the tonnage of vessels compared with the previous year when 156 Liberty vessels accounted for approximately 684,000 tons and 1,120,000 tons gross.

	No. of Arrivals	Net Tonnage	Gross Tonnage
1942-43	374	515-459	865,828
1943-44	454	1,121,384	1,868,890
1944-45	251	409,974	687,902

Wharves

Ocean Pier.—In January last the Engineer reported on the various practicable methods of reconstructing and extending Ocean Pier. Authority had been received from the Loan Council for borrowing up to £50,000 for work on this pier during 1944-45.

The Engineer recommended that concrete apron strips of about 30-ft. in width be built on each side of the old pier and that they be well tied to the old woodwork and to each other with a concrete transverse waling. The cost of the complete renewal of the Pier, including the rebuilding of No. 1 and No. 2 sheds, was estimated at £197,500.

Queen's Pier.—An underwater inspection of the piles in this pier revealed that some 300 new piles were required immediately in order to put the structure in a reasonably sound condition.

The Board decided that as the King's Pier was in a similar condition and the Port could not afford to have both these Piers out of commission at the one time, large scale repairs would have to be carried out on one pier before reconstruction of the other could be proceeded with.

It was decided that, as the Queen's Pier provided the best accommodation, it be renewed.

The cost of the work was originally estimated at £13,000, but subsequent decisions to level the wharf apron on the Northern side by means of a concrete super-imposed deck and to provide additional strengthening on the inner end of the South side to accommodate the 25-ton steam crane, during the reconstruction of the King's Pier, will greatly add to the cost.

King's Pier.—In view of the inadequate shed accommodation on this pier, the cost of the large-scale renewals urgently needed was not considered warranted. It was decided, therefore, that this pier be replaced with a concrete structure of the greatest dimensions possible.

The newly appointed Engineer-in-Charge submitted four alternative proposals for future development in this locality.

A scheme providing for a pier 690 feet long on the South side and 630 on the North side, and 140 feet wide, was adopted. The dimensions of the shed will be approximately 550 feet by 80 feet.

Authority has been received for the Board to borrow up to £100,000 during the current financial year.

Survey of Tasmanian Coasts

Advice has been received, through the Lands and Surveys Department, that the Commonwealth is now in a position to proceed with Hydrographic Surveys of the Tasmanian Coasts. As a first step, an immediate survey of the whole of the North Coast is to be undertaken by the Navy Department.

Notes of the Month

Thurso Harbour Trust Modernising Scheme.

Thurso Harbour Trust are to erect two concrete groins and reconstruct a quay to bring the harbour into line with modern requirements. A grant of £17,000 has been advanced by the Development Commissioners to facilitate the work, which is the first part of a scheme which will involve a total cost of approximately £60,000.

New Gates for Portishead Dock.

The two sets of lock gates, outer and inner, at Portishead Dock, are to be replaced by gates which will be built at Barrow-in-Furness, on behalf of the Port of Bristol Authority. The work, which is expected to take about five months, will not necessitate the closing of the dock for the whole of that time, but only at certain stages of the task, due notice of which will be given by the port management.

New Sections for Bergen Floating Dock.

A contract has been received by Messrs. Head Wrightson & Co., Ltd., Thornaby-on-Tees, to construct two sections of a large floating dock to replace the one destroyed by the Germans at Bergen. About 1,000 tons of steel will be used in the work, which is being undertaken for the A/S. Bergens Mek. Verksteder. It is expected the first section will be delivered in the autumn and the second by the end of the year.

The Future of Faslane Military Port.

The Clyde Navigation Trustees, after considering offers from two companies for accommodation within the military port at Faslane, Gareloch, for shipbreaking and ancillary purposes, have recommended to the Ministry of Transport that the available accommodation should be leased for specified purposes, that the trustees should be parties to any agreement, and that the Admiralty needs should be catered for at other ports in the Clyde area, so relieving berthage for shipbreaking at Faslane.

Dutch Port Scheme Criticised.

A recent issue of the *Scandinavian Shipping Gazette* reports that severe criticism is being levied against the Dutch Government's proposal to form a National Port Board, which is to act as an advisory council to a Director-General of Seaports and Rhine shipping. No details of the proposed new organisation have yet been published, but the Rotterdam Chamber of Commerce and the Shipping Federation at Rotterdam have lodged protests against the plan, which, in their opinion, will seriously interfere with private enterprise.

Rehabilitation of the Port of Zeebrugge.

With the repair of installations at the Port of Zeebrugge nearly completed, the Zeebrugge-Harwich service is expected to resume operations this month. The service will commence with a single boat, two ferries of this line having been destroyed during the war and not yet replaced. In the fishing port, the auction mart and storehouses which were completely demolished by the Germans have been replaced by temporary sheds. Also, the boat-building yards have been repaired and the mole, which was heavily damaged by explosions, has been rebuilt. The work of removing a number of wrecked steamers and trawlers, which were deeply embedded in the mud of the roads is nearing completion.

Wharf Extension at the Port of Belfast.

The extension and deepening of the power station wharf in the Musgrave Channel to meet with the Belfast Corporation's £1,000,000 scheme for increasing electrical output has been authorised by the Belfast Harbour Commissioners. To improve the coal-handling facilities, the wharf will be widened by 16-ft. and extended by 75-ft. at the north end and the depth will be increased from 17-ft. to 20-ft. at ordinary low water. Since it was constructed in 1923, under an agreement with the Corporation, the tonnage of coal handled has increased from 25,000 to 205,000 annually. Work on the extension is to begin at an early date.

Chilian Port Director in Britain.

Senor Ricardo Santander Godoy, director of ports of the Ministry of Public Works in Chile recently arrived in England on a visit under the auspices of the British Council to study ports, shipyards and the making of port equipment. He will also visit universities and technical colleges.

Rhine Navigation Extended.

Early last month, the locks at the Kembs Dam on the Rhine 2½ miles from Basle, were brought back into service for the first time since they were destroyed by the Royal Air Force in 1944. These repairs enable navigation to be carried out from Basle to the sea.

Alexandria Floating Dock to be Transferred to Bermuda.

Two Admiralty tugs have been commissioned to tow to Bermuda the Admiralty floating dock which has been stationed at Alexandria since the beginning of the war. The dock is being transferred to Bermuda to replace the existing one which is now obsolete.

New Freight Service for Southampton.

Two Dutch Shipping Companies, the Nederland Line and Rotterdam Lloyd, have started a monthly service from Southampton to the Far East, thereby providing new facilities for exports to that part of the world. Both companies regularly used the Southern Railway Docks at Southampton before the war.

Gothenburg Harbour Extensions.

The Gothenburg Harbour Administration has submitted to the Town Council a scheme for the extension of the harbour. Among other improvements, the plan provides for a pier to serve traffic with Great Britain and overseas countries. The scheme is estimated to cost kr. 40 million and the work is expected to be started this autumn.

Dredging at Port of Southampton.

It is reported that an extensive dredging programme is to be carried out at the Port of Southampton, and priority is to be given to restoring the Middle Swinging Ground to its proper depth. It is estimated that 260,000 cub. yds. of spoil will have to be removed to restore the area to a minimum depth of 36-ft. at L.W.O.S.T.

Floating Dock for Stockholm.

A new floating dock for Stockholm has been ordered by the Stockholms Rederi AB. Svea, and will be constructed at a British East Coat shipyard. The dock will be of the modern sectional box type with a capacity of 9,000 tons and a length of 532-ft., and will be able to accommodate large vessels, including tankers of 15,000 d.w. tons. It is expected the dock will be completed by next September and will be ready for use in April, 1947.

Philippines Lighthouse Service.

It is reported that the lighthouse service in the Philippine Islands has been partially restored with the installation of temporary lights on various lighthouses in the southern islands and northern Luzon. About 75 per cent. of the entire lighthouses which had been destroyed or damaged during the Japanese occupation are now operating with lights derived from batteries installed by the United States Navy.

Limerick Harbour Plans.

Among the post-war plans of the Limerick Harbour Commissioners is the construction of a deep-water wharf to accommodate vessels with a draft up to 26-ft., and a proposal to connect the ocean-going harbour with the canal harbour is also receiving consideration. Work on the extension of the dock basin and the construction of a new entrance at the west end of the basin was begun before 1938, but was held up by the war. This work is expected to be completed at an early date.

Reinforced Concrete Caissons for Marine Works

An Article for Students and Junior Engineers

By STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

General

REINFORCED concrete caissons have been in use since about 1910 in the construction of breakwaters, wet dock wharf walls and piers, notably at Marseilles, Rotterdam, Dordrecht, Alexandria, Naples, Danzig, Gdynia, Sourabaya and Kobe; but they may also be utilised for the building of sea walls, dolphins, river training walls, and for ship and sliding caissons for closing dock entrances.

In most cases the caissons have been built in either an offshore depositing dock, a dry dock, or in a floating dock, also on shore slipways; then launched and towed by tug boats to the site where they are required to be deposited, which is generally not very far from the spot at which they have been constructed. Steel-built floating docks and caissons for closing dock entrances, also reinforced concrete docks, have been in several instances towed safely over the oceans to distant ports, but the recent achievement of towing a considerable number of reinforced concrete caissons from England to the coast of Normandy for the purpose of forming a harbour and landing piers, is the first time that such caissons in large numbers have been safely floated over long distances, and proves that they can be made capable of withstanding the strains.

Such caissons require thicker walls, and more bracing and strengthening than those which are to be floated for short distances; the walls and floors are thicker than those of reinforced concrete ships, because there are no ribs and the bulkheads are spaced further apart, they will also be required to withstand the lateral pressure of the ballast and filling after they have been sunk *in sitû*. If concrete filling is used there may be a lateral pressure of from 75 to 85 lbs. per sq. ft. less the water pressure, on the walls, until the concrete has set hard. In some instances where these caissons have been used for wet dock walls, the filling has consisted of sand and gravel ballast, and even dredged material pumped direct into the caissons, in which cases there will be a permanent lateral water pressure on the front walls, partly counterbalanced by the filling pressure, while the earth pressure and superloads on the wharf at the back will exceed the filling pressure. When floating out, the water pressure on the sides and bottom will be equivalent to the draught, and the steel tension rods should be near the insides of the wall and floor, and close to the outsides at cross bulkhead supports, as in continuous beams, or beams with fixed ends; but when sunk and filled with sand and gravel, steel tension rods may also be necessary near the outside of the bottom, as the weight of the filling will exceed the upward water pressure, but if the ground will support the loads safely, these rods will not be required.

If the caissons are sunk in sitû by flooding with water either through sluice valves near the bottom, or by pumping in water, and it is required to fill the interiors with concrete in the dry, the sluices are closed, and concrete blocks of sufficient weight to keep the caisson sunk while the water is being pumped out, are placed inside by a floating crane. Mass concrete filling can then be deposited through a tremie or tube, and for this purpose, barges or lighters with the aggregate and concrete mixer with crane and buckets must lie alongside the caisson, the contents of the buckets being tipped into a hopper at the top of the tremie, or direct into the caisson. If the caisson contains more than 25-ft. of water, the suction pipe of the pump must not exceed that length, and the pump will require to be slung from a crane or gradually lowered from a staging at the top of the caisson to deal with the remaining depth of water, or standpipe pumps and Pulsometers may be used.

As these caissons are heavy, weighing from 28 to 35, and 48 to 66 lbs. per cub. ft. of external measurements, depending on the thickness of the walls, floors, and number of bulkheads, their draught, when launched, is considerable in proportion to their size, and they should preferably be constructed in a dry dock, a floating dock if available, in which a number may be built at the same time.

If a shore slipway is used, water at least 20-ft. deep will be required at the lower end

In some instances they have been launched lying on one side with the bottom facing the lower end of the slipway, the top being temporarily closed with timber planks, the caissons were pulled into the water by tugs and righted by pumping a certain amount of water into them, from pumps in a vessel lying a short distance away, the delivery main being suspended from the mast of the ship.

In tidal harbours where portions near the shore are dry at low tides, the caisson may be constructed on a level timber grid or an inclined hard; the first portion of the work will be tidal, and a quick-setting cement may be used; as the work proceeds, a time will come when a caisson will be waterborne and after the water has been drained out through sluice valves near the bottom, it can be floated away from the grid and completed near the harbour walls, the construction of another caisson having been begun on the grid in the meantime.

For instance, in the case of a caisson 80-ft. by 20-ft. by 36-ft. high, similar to that shown by Figs. 3 and 4, the total weight will be about 906 tons, and the floating-out draught will be 19.8-ft., say 20-ft., the lower 12-ft. will weigh 456 tons, and the water displaced per 1-ft. depth = 80-ft. by 20-ft. by 1-ft. = 1,600 cub. ft., which divided by 35 cub. ft. per ton for salt water = 45.71 tons,

therefore $\dfrac{456}{45.71} = 9.9$-ft., say 10-ft. draught, thus leaving 2-ft. freeboard for floating, and 24-ft. to be completed off the grid. Sand and gravel filling should preferably only be used in caissons intended for jetty piers, and training walls, although these materials have also been used in those for wharf walls to reduce the load on the sea bed; but where weight is necessary, as in wharf walls, breakwaters, sea walls, and dolphins for mooring ships, the filling should consist of either mass concrete or concrete blockwork.

Shape of Caissons

Most of the caissons constructed have been rectangular in plan, some are formed with a taper or batter inwards from the bottom to the top to reduce the weight, and increase the stability by thus extending the width of the base, which is also assisted by adding a toe on each side.

The square shape of the ends increases the resistance for towing purposes, but there is no reason why the ends should not be triangular or semi-circular in plan, which will reduce the resistance to wind and water to about half that of square ends. If one end of a caisson is triangular in plan, and the other has an inverted triangle, or convex and concave curves respectively, a line of such caissons can thus be keyed together and form a continuous wall; while those with semi-circular ends will be suitable for a curved wall.

Thickness of Walls and Bottom

The thickness of the walls of caissons varies usually, from 8 to 12-in. at the top, to 18 and 24-in. at the base, either tapered or with steps at intervals in the height. In some cases they are made 10-in. to 12-in. thick throughout, with bulkheads 8-in., 10-in. and 12-in. thick; while the bottom thickness varies from 18 to 24-in., although some are less than 18-in. and others more than 24-in. It depends on the distance apart of the bulkheads or cross walls, and longitudinal bulkhead walls, in which openings are sometimes left to reduce the weight. It is not advisable to

Reinforced Concrete Caissons for Marine Works—continued

make the exterior walls less than 8-in. thick, because cracks may occur due to the contraction of the concrete when setting, with the result that water will percolate to the steelwork, setting up rapid corrosion that will further crack and burst the concrete; for this reason the steel rods should have a cover of concrete 2-in. thick from the outer face.

In reinforced concrete ships of small size, the skin thickness is varied according to the displacement tonnage being 2-in. for 100 tons, 3-in. for 300 tons and 4-in. for 1,000 tons, and thin rods are used, the supporting ribs being 3 to 4-ft. apart, and from 3 to 4 per cent of steel is employed.

The thicker the bottom of the caisson is made, the less steel will be required, and less ballast will be necessary to sink it, but the greater will be the floating-out draught.

Concrete Proportions and Strength

The specific gravity of Portland cement varies between 3.0 and 3.25, these figures correspond to 187.5 and 203.12 lbs. per cub. ft. respectively, but the actual weight of the powder in bulk may be 80, 90, 100 up to 124 lbs. per cub. ft. according to the amount of compression, and for gauging the quantity of cement an average of 100 lbs. per cub. ft. is usually taken. The specific gravity should not be less than 3.10 to 3.15 and 35 to 36 cub. ft. of aggregate in the dry state is required per 27 cub. ft. of concrete. In reinforced concrete ships the best proportions for the concrete are 952 lbs. cement, 13.5 cub. ft. sand, and 27 cub. ft. of $\frac{3}{8}$-in. gravel, these with cement at 100 lbs. cub. ft. is a proportion of 1-1.4-2.8. Stronger concrete in the proportions of 1-1.33-1.66 has also been employed. In some caissons a mixture of 672 lbs. cement, 13.5 cub. ft. sand, and 27 cub. ft. gravel has been used=1-2-4 and for thin bulkhead walls, 650 lbs. cement, 13.5 cub. ft. sand, and 19.5 cub. ft. of gravel up to $\frac{3}{4}$-in. size=1-2-3, but it is advisable to use this proportion throughout. The aggregate should be free of earth, mud, and vegetable matter, and up to 5% of mud has not been found to be injurious, but 10% of silt in 1-2-4 concrete reduces its strength by 4.5%, and 14% of silt, will reduce it by 15%.

The crushing strength of concrete depends on the proportions, the water content and its age. It varies considerably, the strength increases for the first three months of setting at the rate of about 25 to 35 lbs. per sq. in. per day, in a curve, and then for 12 to 18 months at about 1 lb. per sq. in. per day, in a straight line; the average for the first 12 months is about 6 lbs. per sq. in. per day. The crushing strength of 1-2-4 gravel concrete 7 days' old varies between 2,920 to 3,468 lbs. per sq. in., the minimum may be taken at 2,500 lbs. and the safe compression at 650 lbs. per sq. in., while the tensile strength is about 1/7th to 1/10th of the compression. The adhesion of fresh concrete to existing concrete surfaces when wetted, is about 126 lbs. per sq. in., when the surface is roughened and wetted it is 185 lbs., and when coated with neat cement, it increases to 281 lbs. per sq. in., so that it is very important to coat existing concrete surfaces with cement before adding fresh concrete.

The safe shear on concrete may be taken at 50 to 60 lbs. per sq. in. The maximum adhesion of concrete to clean steel rods, varies with the age of the concrete; in experiments made with a 1-2-3 mixture, $2\frac{1}{2}$ months old, the steel rods were pulled out at 396 to 614 lbs. per sq. in. of surface area, in 4 months at 422 to 790 lbs.; and in 9 months at 505 to 743 lbs. per sq. in.

The safe adhesion may be taken at 80 to 100 lbs. per surface sq. in. Concrete blocks for ballasting may be made in the proportions of 600 lbs. cement, 15 cub. ft. sand, and 30 cub. ft. gravel or stones up to $1\frac{1}{2}$-in. size=1-$2\frac{1}{2}$-5.

Steelwork

The maximum tensile strength of mild steel rods varies from 26 to 33 tons per sq. in. and the safe stress may be taken at from 7 to 8 tons per sq. in. or 15,680 to 17,920 lbs. respectively, and the safe shear at 10,000 to 12,000 lbs. per sq. in., or 4.46 to 5.35 tons per sq. in.

The area of steel rods required may be calculated as for beams with fixed ends, the net bending moments at the centre= $\frac{W.L.}{24}$ and at the bulkhead supports= $\frac{W.L.}{12}$.

In the floor the shortest span between the walls and bulkheads should be taken as the length, the main rods running in that direction and the distribution rods in the opposite direction. If the bottom of the caisson is treated as a slab supported on 4 sides by the walls and bulkheads, the bending moment at the centre is problematical due to the scarcity of reliable tests, in some cases it is taken at $\frac{W.L.}{16}$ and in others at $\frac{W.L.}{20}$.

In the side walls and bulkheads the main tension rods will run horizontally, and the $\frac{3}{8}$-in. diameter distribution rods, will be vertical, spaced one foot apart.

Not much reinforcement will be necessary in the longitudinal and cross bulkheads, as there will be little stress, if the filling of the cells is continued uniformly.

It is better to use rods of small diameter in preference to thick ones, because two small rods of the same sectional area as one larger one, will have a greater surface area for adhesion purposes, and small diameter rods can be bent cold, while thick ones over 1-in. diameter require to be heated, which reduces their tensile strength.

Steel rods may be obtained in lengths of 75-ft. when required for piles, but for easy handling the lengths should not exceed 40-ft. as longer ones are difficult to convey by road or rail. All rust and mill scale should be removed from the rods, and it is advisable to use hooked ends instead of split or fish-tail ones, as the former have a stronger hold.

Construction of Caissons

Whether a caisson is built on a slipway, in a dry dock, or a floating dock, the procedure of construction is much the same. Close timber cross-planking 9-ft. by 3-in. for 6-ft. spans, or 12-in. by 4-in. for 10-ft. spans, between the supports on a slipway; or $1\frac{1}{2}$-in. planks laid direct on a dock floor must first be formed for the bottom of the caisson, and $1\frac{1}{2}$-in. to 2-in. thick horizontal shuttering for the walls and bulkheads, both inside and outside, the required distance apart for the thickness, with strong vertical supports at intervals of about 6-ft. will require to be erected.

Metal forms of cast iron or steel sheets are also used as shuttering, and all shuttering should be coated on the face next the concrete with lime or grease to prevent adhesion to the concrete.

The floor planks should be covered with bitumen sheeting or tarred felt. The scaffolding and shuttering entails the use of a considerable amount of timber.

In some cases to deliver the concrete to the caisson shuttering, a vertical steel or timber-framed tower higher than the top of the caisson is erected alongside and stayed by wire ropes, and another short frame at some distance from it, two steel beams a few feet apart are fixed on an incline between the tops of the frames, having rollers at intervals between them.

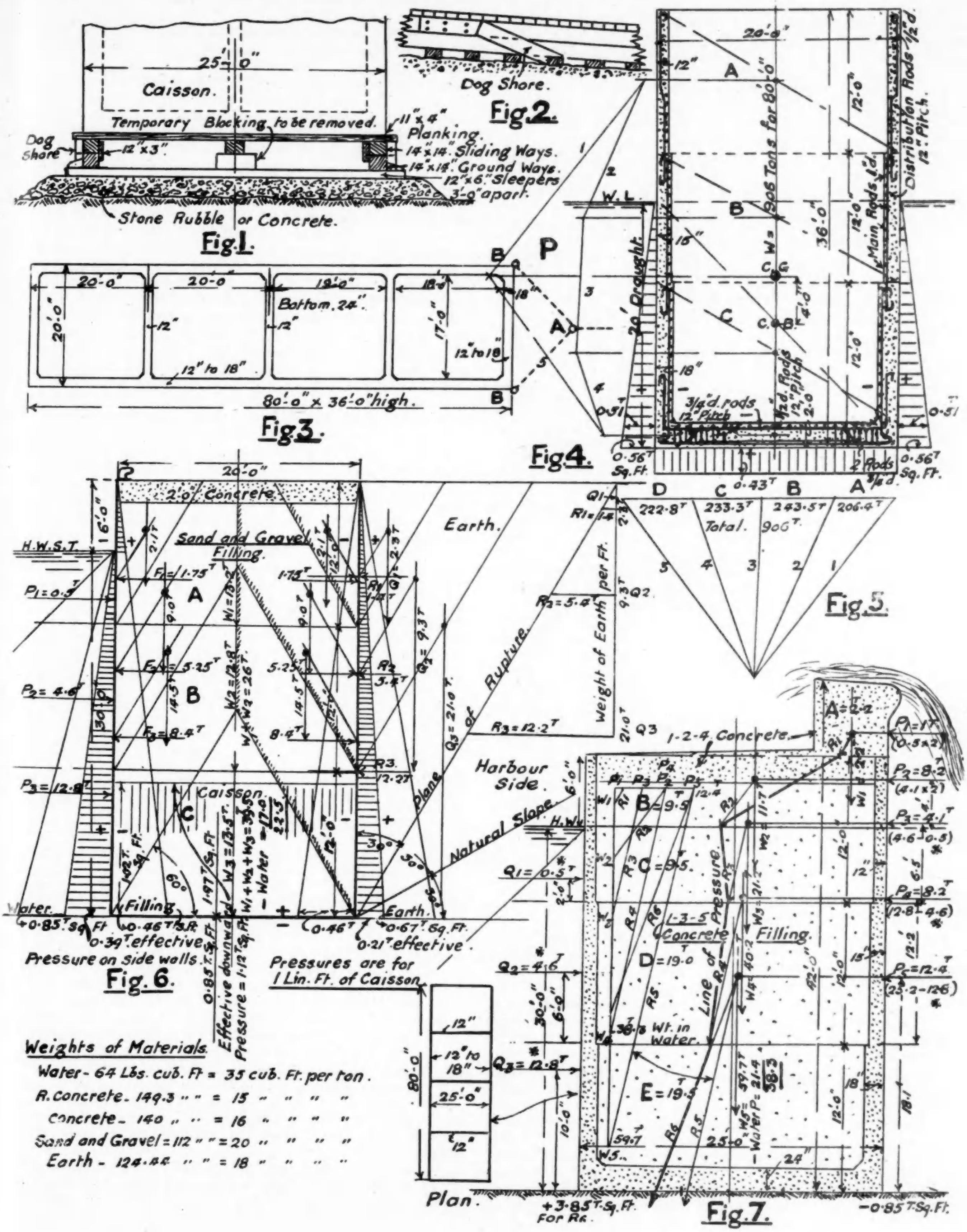
At the top of each frame is a revolving hexagonal tumbler, on a steel shaft passing through the ends of the beams, over which passes an endless chain of buckets linked together, very similar to the ladder and buckets of a dredger, but of much lighter construction.

On the lower tumbler shaft a spur wheel is fixed, this is driven by a pinion connected through gearing to a Diesel engine or an electric motor.

The concrete mixing machine is placed on a platform above the ground, and delivers its contents into a hopper which fills the buckets of the conveyor, these tip into another hopper near the top of the tall tower, this hopper is connected to an iron tremie or chute supported by wire ropes to a cable stretched between the tower and a mast some distance away, the tremie being carried down to the points of deposit.

In other instances in lieu of a bucket conveyor, a $\frac{1}{2}$ cub. yd. capacity bucket with a hinged bottom is slung by a wire rope over a pulley at the top of the tower, the rope being connected to a winch at the base. A hopper with the tremie attached to it,

Reinforced Concrete Caissons for Marine Works—continued



Reinforced Concrete Caissons for Marine Works—continued

is also slung from the top of the tower lower down, and can be raised or lowered as required.

The bucket is filled with concrete direct from the mixer, and discharges into the hopper attached to the tremie, a small platform being fixed to the tower under the hopper so that a man can discharge the bucket. Another method of depositing the concrete is to hoist the bucket with a long jib crane, and discharge it into the space between the shuttering; the concrete mixer travels on rails and fills a number of buckets placed in line.

When bucket conveyors and tremies are used, the concrete must be very liquid, and the cement contents increased, as a certain amount will be lost by adhering to the buckets and chutes, the latter should be carried down so near the point of deposit as possible, otherwise if allowed to drop from a height, the aggregate will separate from the cement, and a poor mixture will result. The concrete should be allowed to set for about one month before launching the caissons.

Launching Caissons from Slipways

As reinforced concrete caissons are heavy in comparison with their size, the slipways on which they are built should be as strong as those required for launching ships; for instance, a caisson 80-ft. by 25-ft. by 36-ft. high will weigh about 1022.5 tons or 12.78 tons per lin. ft. = 6.39 tons per lin. ft. on each of two sliding ways, and some are heavier than this. A 600-ft. ship of 18,000 tons displacement would have a launching weight of about 18,000 by 0.45 = 8,100 tons or 13.5 tons per lin. ft. on the average, or 6.75 tons per lin. ft. on the sliding ways.

A cross section of a slipway on firm ground is shown by Fig. 1, it should have an inclination of at least ½-in. per lin. ft. = 1 in 24 or ⅝-in. per ft = 1 in 19.2.

The ground ways and sliding ways under the caisson should be well greased on their meeting surfaces, before the caisson is constructed, the sliding ways being held by dog shores of timber, butting against timber chocks bolted to the outside of the sliding ways, as shown in Fig. 2, the lower ends of the inclined shores pressing against short piles in the ground, or butting against the cross sleepers.

The timber planks for the bottom of the caisson are spiked to the sliding ways, and the caisson will be constructed on an inclination, but if it is required to build it vertically the sliding ways must be built up with tapered baulks of timber or blocks at intervals to form a level bench on which to lay the planking, the timbers being fastened together with iron clamps.

In some cases caissons are launched from slipways broadside on, and as there will be a number of sliding ways about 20-ft. apart, their total length will be longer than that of two sliding ways for end launching.

When the caisson is launched, the sliding ways and planking will separate from the caisson, and float to the surface of the water, as the caisson is pulled away, and can then be reused for the construction of another. Launching from slipways should be carried out at H.W.S.T. at slack water.

Towing Caissons

When towing caissons to the site where they are required to be deposited, in some instances wire ropes or chains are passed round the body of the caisson just above the water level, the corners being protected by fendering of compact rope pads and timber wedges; and in other cases by fixing ring bolts at the corners, the rods of these should be well bedded for 5 or 6-ft. lengths in the side walls; shackles with chains or wire ropes are attached to these and to another ring to which the towing hawser is connected, as shown in the plan of Fig. 3.

Assuming that the pull on the main hawser is 8 tons, then the pull on each of the slings between rings A and B, at 45 degrees will be $\frac{8 \times 1.414}{2}$ = 5.656 tons, and the maximum on ring A = 5.656 x 2 = 11.312 tons. This ring is 9-in. internal diameter, and the proof load in cwts. that will not cause deformation = $1\frac{1}{4}$ (d^2) where the d = the thickness of the metal in the ring in eighths of an inch. If d = $2\frac{3}{8}$-in. diameter, then $1\frac{1}{4} \times (19)^2$ = 451.25 cwts. = 22.56 tons, and taking half this as the safe load = 11.28 tons.

In rings B, also 9-in. diameter, the strain on each is 5.656 tons and if d = $1\frac{3}{4}$-in. then the proof load will be = 12.25 tons and 6.04 tons safe.

The ring bolt bars of rings B being parallel to the pull will each have a load of 4 tons, and if d = 1-in. = 0.78 sq. in. at 6 tons safe stress = 4.68 tons. The circular area per lin. ft. = 1-in. by 3.14 by 12-in. = 37.68 sq. in., which at 80 lbs. = 3014.4 lbs. The pull is 4 tons = 8,960 lbs, and $\frac{8960}{3014.4}$ = 2.97 say 3-ft. length in the concrete is required for adhesion, but it is advisable to increase this to 5 or 6-ft. to allow for the concrete being "green."

The main wire rope hawser will require to be 4-in. girth, with a B.W. of 33 tons, and the hawsers between the rings of $3\frac{1}{2}$-in. girth each having a B.W. of 26 tons. There are certain resistances to be overcome when towing caissons, depending on the direction and velocity of the wind, the tidal currents and state of the sea.

For example, in the case of a caisson 80-ft. by 20-ft. by 36-ft. high, the draught will be 20-ft. and the freeboard 16-ft.

Assuming a wind pressure of 15 lbs. per sq. ft. on the plane surface of the head, it will amount to 20-ft. by 16-ft. by 15 lbs. = 2.1 tons; and on a semi-circular head it will be 15 by 0.67 = 10 lbs. sq. ft. or a total of 1.4 tons, while on a triangular head at 45 degrees, it will amount to 15 by 0.65 = 9.75 lbs. per sq. ft. or 1.3 tons.

If there is a tidal current with a velocity of 4 knots against the head of the caisson, then 4 by 6080 = 24,320-ft. per hour, or a velocity of 6.75-ft. per second; and the water pressure against a plane head will be $P = 1.184 V^2$, where P = pressure in lbs. per sq. ft. and V = velocity of current in ft. per second. For fresh water $P = 1.154 V^2$.

These formulæ are based on the relative weights of air and water, and correspond to a wind pressure $P = 0.00322 V^2$. where P = in lbs. per sq. ft. V = velocity of wind in miles per hour, or $P = 0.1497 V^2$ where V = velocity of wind in ft. per second, and knots x 1.69 = feet per second.

The pressure of the current against a plane head = P = 1.184×6.75^2 = 53.94, say 54 lbs. per sq. ft. and 20 × 20 × 54 = 9.6 tons. On a semi-circular head 20-ft. diameter it will be 6.4 tons, and on a triangular head 6.26 tons.

These figures do not take into account the surging of the water round the caisson, or skin friction on the sides, but these will not amount to much.

The currents in the open sea seldom exceed 0.5 to 1.0 knot, but in narrow straits and channels, and round coasts may be 2 or 3 knots, or even 6 to 8 knots velocity at between 3 or 4 hours before and after high and low water.

Caissons can seldom be towed at velocities of more than $1\frac{1}{2}$ to 2 knots per hour on account of the pitching and surging of the water round them in the open sea. Ring bolts or bollards will be required at the top corners of caissons to get them into position for sinking.

Buoyancy, Centre of Gravity and Ballasting

As most caissons are rectangular in cross section, the centre of gravity (C.G.) will be some distance about the centre of buoyancy (C.B.) unless they are ballasted with water or concrete blocks, preferably with the latter, as water is an unstable ballast.

The higher the C.G. is above the C.B. the more unstable they will be in rough seas, and they will roll considerably, but the wider they are made in proportion to their height the closer will be the C.G. to the C.B. thus increasing their stability.

To ensure complete stability the C.G. should be close to, or better, below the C.B.; but as most caissons are narrow in proportion to their height, this condition cannot be obtained without ballasting, so that it is an advantage to provide them with thick floors.

In the caisson 80-ft. by 20-ft. by 36-ft. high shown by Fig. 3, in plan, and Fig. 4, in cross section, the weight is 906 tons or 11.32 tons per lin ft. and 35.2 lbs. per cub. ft. of external volume.

Reinforced Concrete Caissons for Marine Works—continued

The water displaced per ft. depth $= \dfrac{80\text{-ft.} \times 20\text{-ft.} \times 1\text{-ft.}}{35} =$ 45.71 tons and $\dfrac{906}{45.71} = 19.8$-ft., say 20-ft. draught, and as shown in Fig. 4, the C.G. will be 4-ft. above the C.B., this is too much for complete stability and should be reduced by ballasting.

Fig. 5 is the polar diagram for obtaining the C.G. by the funicular polygon at P.

In all calculations given the cub. ft. per ton of each material is as follows, viz.: salt water, 35; reinforced concrete, 15; mass concrete, 16; sand and gravel, 20; and earthy material, including stones, gravel and clay, 20.

The mass concrete ballast required to sink the caisson at the required site in 30-ft. of water, leaving 6-ft. freeboard = 80-ft. by 20-ft. by 30-ft. = 48,000 cub. ft. which divided by 35 = 1,371 tons less 906 tons = 465 tons of ballast, and 465 by 16 cub. ft. = 7,440 cub. ft. The net dimensions inside the caisson per ft. depth = 74-ft $\times$ 17-ft. $\times$ 1-ft. = 1,258 cub. ft. $\therefore \dfrac{7440}{1258} = 5.9$ say 6-ft. depth of concrete ballast is required.

If the caisson is entirely filled with concrete, 2,776 tons will be necessary, bringing the total weight up to 3,682 tons, the upward water pressure is 1,371 tons, so that the net weight on the sea bed will be 2,311 tons or 1.44 tons per sq. ft.

The water pressure at the bottom of the caisson when floating out with 20-ft. draught (Fig. 4) is 0.56 tons per sq. ft., the weight of the concrete bottom 2-ft. thick is 0.13 tons sq. ft. so that there is a net upward water pressure of 0.43 tons x 17-ft. span = 7.31 tons per lin. ft. of the caisson length.

At the base of the side walls there is a pressure of 0.51 tons per sq. ft. x 19-ft. (the span between the bulkheads) = 9.69 tons, for the lower 1-ft. depth which will diminish up to the water level.

Caisson for Wharf Wall

If this caisson is required for part of a wharf wall, as illustrated by Fig. 6, and is filled with ballast consisting of sand and gravel at 20 cub. ft. per ton, the weight of this will be 2,254 tons plus the reinforced concrete = 906 tons, a total of 3,160 tons, less the upward water pressure of 1,371 tons = 1,789 tons or 1.11 tons per sq. ft. when sunk. In Fig. 6 the angles of repose of the filling inside the caisson, and of the earth backing on the wharf are assumed to be 30 degrees, and the planes of rupture 60 degrees. The wedge of earth pressure at the back of the wall is 21 tons per lin. ft. or 12.2 tons horizontal which divided by $\dfrac{36\text{-ft.} \times 36\text{-ft.} \times 1\text{-ft.}}{2} = 648$, gives 41.71 lbs. per cub. ft. as the equivalent fluid pressure, the pressure at the base will therefore be = 41.71 lbs. by 36-ft. = 1,501.56 lbs. or 0.67 tons sq. ft. The filling inside the caisson against the inner and outer walls will weigh 14.5 tons, with a horizontal pressure of 8.4 tons per ft. and equivalent fluid pressure of 29 lbs. per cub. ft., the pressure at the base will be 0.46 ton per sq. ft., there will therefore be an excess earth pressure at the back of the wall = 0.67 = 0.46 = 0.21 ton per sq. ft. by 19-ft. = 3.99 tons per lin. ft. of caisson. The horizontal water pressure on the face of the wall is 12.8 tons per lin. ft. and 0.85 ton per sq. ft. at the base, therefore the excess water pressure on the face of the wall = 0.85 − 0.46 = 0.39 ton sq. ft. by 19-ft. = 7.41 tons per lin. ft. or less than when floating out.

The filling, including the deck and bottom concrete weighs 1.87 tons per sq. ft. at the base, and deducting the upward water pressure of 0.85 ton, leaves an excess pressure from the filling of 1.02 tons per sq. ft. on the bottom, which the ground may support. As the water pressure on the front of the wall, and the earth pressure at the back nearly balance one another in intensity and height of action, the resultant line of pressure will fall near the centre of the base. The front of the wall will require to be fitted with bollards of cast steel, also ring bolts, fairleads, ladders and timber fendering.

If it is necessary to provide for scour at the toe of caissons or for holes excavated by ships' propellers, or for deepening by future dredging, the caissons should be sunk in a trench 5 or 6-ft. deep.

Caisson for Breakwater

Fig. 7 shows the cross section of a caisson 80-ft. by 25-ft. by 36-ft. high, forming a portion of a breakwater, and surmounted by a concrete parapet wall, added after having been sunk. The weight of the reinforced concrete is about 1022.5 tons, equivalent to 31.81 lbs. per cub. ft. of external volume, the floating out draught will be 18-ft. and the concrete ballast required to sink it in 30-ft. of water is 1714.2 tons, less the upward water pressure (1022.5 tons) = 691.7 tons, which is equal to 6.8-ft. thickness of concrete.

The weight of the caisson when sunk, completely filled with concrete, and including the parapet, will be 59.7 tons per lin. ft. = 2.38 tons per sq. ft. and deducting upward water pressure = 21.4 tons, the net load is 38.3 tons, or 1.5 tons per sq. ft. on the sea bed in a calm sea. In a storm the waves will probably rise to the top of the parapet 12-ft. above high water level, although the foam will be much higher, thus giving a head of 42-ft. of solid water on the outside of the breakwater.

The water pressure on the harbour side due to 30-ft. head (h) is 12.8 tons per lin. ft. and on the outside for a head of 42-ft. (H) it will be 25.2 tons, the effective pressure on the outside will therefore be 25.2 − 12.8 = 12.4 tons, acting on the outside at a height

$$x = \tfrac{1}{3}\left(H + \frac{h^2}{H+h}\right) = \tfrac{1}{3}\left(42 + \frac{30^2}{42+30}\right) = 18.1 \text{ ft.}$$

The water pressure on the 6-ft. high parapet (A) is 0.5 tons per lin. ft. and on sections A and B = 4.1 tons, these pressures have been doubled to provide for blows from the waves, which may amount to even more than these.

The weight of section (A) is 2.2 tons per lin. ft. and of (B) = 9.5 tons, and the mean C.G. of A and B from the harbour side of the wall $= \dfrac{9.5 \times 12.5 + 2.2 \times 22\text{-ft.}}{9.5 + 2.2} = 14.2$-ft.

The C.G.'s of the other sections being found in a similar manner, the diagram of weights and forces is shown in the Fig. also the resultant line of pressure in the body of the wall.

The maximum pressure on the sea bed, allowing for the wall being waterborne will be about 3.85 tons per sq.ft. on the harbour side, with an uplift of 0.85 ton sq. ft. on the outside, so that the breakwater will require to be constructed on a hard sea bed.

(To be continued)

Scientific Instrument Exhibition in Stockholm

Latest Aids to Navigation

An exhibition of scientific instruments is being held at the Technical Museum, Stockholm, from 24th May to 4th June. The exhibition, which was arranged by the Scientific Instrument Manufacturers' Association of Great Britain, has the support of the Board of Trade and of the British Council.

The purpose of the exhibition is to show the progress and development of British instrument manufacture during the war, and was instigated at a conference held in August 1945 at Stockholm, when Mr. A. J. Hughes, of Henry Hughes & Son, Ltd., discussed the advantages of such an exhibition to Swedish industry and British instrument manufacturers with Professor Velander, of the Royal Swedish Institute of Scientific Research. On his return, Mr. Hughes reported his conversation to the Scientific Instrument Manufacturers' Association who, in the Autumn of 1945, concluded negotiations. A very representative Swedish committee has as its chairman Professor Borelius, of the Royal Technical University.

Legal Notes

The Law relating to the Pollution of Rivers and Streams*

By G. E. WALKER, M.A., LL.B. (Cantab), M.Inst.S.P.
(Secretary and Solicitor, Conservators of River Thames).

(Continued from page 25)

PRIVATE ACTS

I now propose to deal with certain special or local Acts concerned with the prevention of pollution. These relate to special areas and/or streams and are local in character although large and very important areas or districts of the country are affected thereby. It is not, however, possible within the limits of this Paper to give more than a brief mention of these Acts, other than that administered by my own Board, the Conservators of the River Thames, whose jurisdiction for the purpose of the prevention of pollution covers some 3,812 miles and extends to parts of no less than fourteen counties. The importance of the Conservators' pollution prevention activities cannot, however, be too strongly emphasised when it is mentioned that the Metropolitan Water Board takes about two-thirds of its water supply from the River Thames within the Conservators' jurisdiction, and several other water undertakings also obtain water from the Thames or its tributaries.

(a) Lee Conservancy Act, 1868

The Lee Conservancy Board, as well as being empowered by the Rivers Pollution Act, 1876 (Sec. 9), to enforce that Act in the area of their jurisdiction as though they were a sanitary authority, are also empowered to enforce certain provisions of the Lee Conservancy Act, 1868 (as amended by the Lee Conservancy Act, 1900), by resort to the County Court. Under the 1868 Act the Board have also power to enforce those provisions in a Court of summary jurisdiction. The jurisdiction of the Board extends to the River Lee and its tributaries, and here again the importance of pollution prevention is evident as about one-third of the drinking water supply for the Metropolis is obtained from the River Lee area.

(b) West Riding of Yorkshire Rivers Act, 1894.

In addition to the powers of a sanitary authority to enforce the Rivers Pollution Acts, the West Riding of Yorkshire Rivers Board have been empowered by Parliament to take steps in a Court of summary jurisdiction to prevent pollution of the rivers and streams within the West Riding of Yorkshire, or through or by any of the County Boroughs of Bradford, Halifax, Huddersfield, Leeds and Sheffield. The Board thus administers the Act of 1894, and the Rivers Pollution Prevention Acts, 1876 and 1893, in its area.

(c) Port of London (Consolidation) Act, 1920

The jurisdiction of the Port Authority extends to the tidal portion of the River Thames and to streams or parts of streams within the catchment area of the Thames in the Port of London situate within all or any of the several counties of Surrey, Essex and Kent and the administrative County of London (with certain exceptions—Section 226 of the Act). The powers of the Port Authority relating to the prevention of pollution are in the main similar to those of the Conservators of the River Thames which are referred to below.

(d) Thames Conservancy Act, 1932

I have already indicated that it is proposed to deal somewhat fully with the part of this Act which relates to the prevention of pollution. This is contained in Part V of the Act (Sections 119—133), a resumé of which is as follows:—

Sec. 119.

(1) Interpretation Sub-Section (*inter alia*):

"river" includes the River Thames from its rise to the landward limit of the Port of London, i.e., the non-tidal Thames;

"tributary" means and includes the whole and every part of any and every river, stream, watercourse, cut, dock, canal, channel, and water communicating either directly or indirectly with the river, and being within the area included within the limits shown on the deposited map;

"deposited map" in effect is the Catchment area map of the non-tidal Thames.

(2) The deposited map is conclusive evidence as to the extent of the area included in the said limits.

Sec. 120.

Duty of Conservators by all lawful and proper means to preserve flow and purity of water of the river and its tributaries and to cause surface of river and its tributaries within three miles of the river to be (as far as reasonably practicable) effectually scavenged.

Sec. 121.

(1) (a) Ballast, rubbish, etc., not to be thrown into river or tributaries.

(b) Oil or tar not to be caused or suffered to flow or pass into river or tributaries.

Penalty: Not exceeding £50 and a daily penalty of £10.

Proviso: Local authority not deemed to have committed offence under paragraph (b) in construction, maintenance or repair, of highways if reasonable preventive measures taken.

(2) Master and owner of vessel liable to be proceeded against under this Section, but both cannot be punished for the same offence.

Sec. 122.

(1) Ballast or any stones, earth, mud, ashes, dirt, refuse, oil or rubbish not to be deposited so as to drain, be blown or pass into river or any tributary by floods, tides, etc. Conservators may serve notice requiring removal of same or steps to prevent such depositing.

(2) Person not complying with notice may be summoned before Court of summary jurisdiction to shown cause why requirement not complied with. Court may order removal within period not exceeding one month. Conservators' reasonable costs in the matter to be paid.

(3) Penalty for disobeying order of Court: Not exceeding £5—daily 40s. Conservators may do work and recover expenses from person concerned.

Sec. 123.

No person shall without lawful excuse (the proof whereof shall lie upon him):—

(a) Open into the river or any tributary any sewer, drain, pipe, or channel whereby sewage or any offensive or injurious matter, whether solid or liquid, shall or is likely to flow or pass into the river or into such tributary.

(b) Wilfully cause or knowingly suffer any sewage or any offensive or injurious matter, whether solid or fluid, to flow or pass into the river or into any tributary.

Penalty: Not exceeding £100—daily, £50 in each case.

Proviso: This section shall not prevent the opening into the river, or tributary of any sewer, drain, etc., connecting with works constructed by a local authority after 1st January, 1925, with the approval of the Ministry of Health for purification of sewage, but it does not authorise the passage of any offensive or injurious matter through such drain, etc.

Further Proviso: Paragraph (b) not to apply to any sewage, etc., so flowing into river or tributary through sewer, drain, pipe, or channel which on the 17th August, 1894, was lawfully used for that purpose.

Sec. 124.

Whenever sewage or any offensive or injurious matter is caused or suffered to flow into the river or any tributary, the Conservators may and (as regards the flow, etc., of sewage, etc., into any tributary situate within the counties of Bedford, Northampton.

* Excerpts from a Paper read at a Sessional Meeting of the Institution of Sanitary Engineers.

Legal Notes—*continued*

Warwick, Worcester, East Sussex or West Sussex) shall give notice in writing to discontinue within a period of not less than three months.

(2) Conservators may extend time under notice if they think fit by another notice in writing.

(3) Any person aggrieved by reason of notice being in his opinion insufficient may demand an extension of time and in the event of the Conservators refusing to comply, the matter is referred to an arbitrator (to be appointed by agreement of failing agreement by the Minister of Health, on the application of either party) who shall have power to extend time.

(4) Person under notice to discontinue flow, etc., within the time allowed and in default to be guilty of a misdemeanour and liable to be summoned accordingly.

Penalty: Not exceeding £100—daily, £50.

Proceedings may be removed by *certiorari* into the High Court.

(5) After conviction under this Section, Conservators may with sanction of the Court which so convicted (but not otherwise) stop up and keep stopped up outlet of sewer, etc., and for that purpose do all works that appear requisite and may enter upon lands. Conservators to recover expenses with costs either summarily or in any Court of competent jurisdiction. If any person, obstructs or hinders, etc., he shall be liable to a penalty not exceeding £20.

Proviso: No sewer, etc., discharging into river and vested in any local authority shall be stopped up if such local authority has taken or is taking all practical means to secure conviction of actual offender.

(6) Notice under this section shall continue in force notwithstanding temporary suspension of flow of sewage or change of ownership of land and shall affect successive owners, etc., with same obligations.

(7) When notice of discontinuance has been given in respect of manufacturing premises, not situate in a town and for three years after the expiration of time allowed no proceedings have been taken by the Conservators for default, then no proceedings shall be taken unless the Conservators shall have given a renewal or copy of such notice and one month has elapsed after receipt of such notice without the same having been complied with.

Sec. 125.

Where any sewage or any offensive or injurious matter, etc., passes into the river or into any tributary through any sewer, drain, pipe or channel vested in a sanitary authority, the sanitary authority shall be deemed knowingly to suffer the same.

Proviso: No liability if sanitary authority has taken or takes all practical means to prevent the passage or to procure the conviction of the actual offender.

Sec. 126.

(1) Conservators and their officers on production of appropriate authority may enter, examine and lay open and inspect lands or premises between hours of 9 a.m. and 4 p.m.

(2) Application to Court of summary jurisdiction if (after notice) permission to enter refused, and Court may make appropriate order.

(3) Order made under this Section to continue in force until examination complete.

(4) Refusal to obey order: Penalty not exceeding £5.

(5) After completion of examination Conservators to fill in and make good surface of land and restore same as near as may be to former condition.

(6) Compensation for damage caused by entry—dispute as to damage or compensation, in default of agreement, to be ascertained by and recovered before Court of summary jurisdiction.

Sec. 127.

Sanitary authorities, owners and occupiers of land, within area of deposited map, on, in, through or under which any sewer or drain is situate, shall within 28 days after application in writing made to them by the Conservators:—

(*a*) produce for inspection plans of such sewer or drain;
(*b*) furnish copies at reasonable charges;
(*c*) furnish information as to sewer, etc., ownership of, and control over the same.

Penalty for default not exceeding £5.

Sec. 128.

Conservators and their officers on production of authority, if required, may once in every year, inspect sanitary arrangements of vessels (or oftener if reasonable cause to suspect alteration since last inspection) on the River Thames above Teddington Lock, to ascertain whether sewage, etc., can pass into Thames therefrom.

Sec. 129.

(1) Persons cutting and employers knowingly suffering employees to cut weeds, etc., in the river or in any tributary, to remove such weeds, etc., after cutting, to prevent decay and contamination of river or tributary.

(2) No weeds, grass, etc., to be thrown or swept into river or any tributary.

(3) Penalty for contravention: Not exceeding £5.

Sec. 130.

Right to prosecute under the Act as regards pollution to be in Conservators, their Officers, Solicitors or Agents only.

Sec. 131.

Act not to legalise nuisances or affect other remedies.

Sec. 132.

(1) On complaint being made to Minister of Health by the Conservators that any sanitary authority within the limits shown on deposited map which is liable to floods has not exercised their duties, etc., in cleansing of cesspools, etc., Minister may call for explanation. If explanation insufficient Minister may make Order.

(2) Minister may hold enquiry for purposes of this Section.

Sec. 133.

Nothing in provisions of this Act relating to pollution shall prevent the use of streams, etc., for cultivating watercress.

N.B.—By Section 238 of the Thames Conservancy Act, 1932, every person who obstructs, etc., Conservators or Officers, in execution of duty shall be liable to a penalty not exceeding £5.

Before leaving the Thames Conservancy Act, it should be mentioned that no standard of purity as regards samples of effluents and so on is prescribed by such Act. It is a question in each case whether the discharge is sewage or offensive or injurious within the meaning of the Act, which question, in case of dispute, can only be decided by the Courts. Neither is any distinction made, in the application of the Act, as regards any differences in local conditions, such as the volume of the stream water receiving the discharge or the distance of the polluted stream from the main river.

I should add that, for the present administration of the Act of 1932, the Conservators are guided by the advice of their Analyst as to whether a discharge or effluent can be deemed to be "offensive or injurious," and the Analyst, in turn, follows generally the recommendations of the Royal Commission on Sewage Disposal. Such Analyst regards an effluent as infringing if:—

> the albuminoid ammonia exceeds 0.2 part per 100,000 parts;
> the suspended matter exceeds 3.0 parts per 100,000 parts;
> the dissolved atmospheric oxygen absorbed in 5 days exceeds 2.0 parts per 100,000 parts;

in such effluent.

However, in two cases in the Thames Watershed a definite standard of purity has been laid down and approved by Parliament, i.e., in Section 32 (2) of the Wimbledon Corporation Act, 1933 (in respect of drainage from a burial ground), and Section 46 of the Hertfordshire County Council (Colne Valley Sewerage). Act, 1937 (in respect of drainage to the River Colne from the Colne Valley Sewerage Boards Sewage Disposal Works). The standard, which is the same in both cases, is as follows:—

> The discharge (or effluent) shall not contain more than 3 parts of suspended matter per 100,000 parts, and (including its suspended matters) it shall not take up more than 2 parts of dissolved oxygen per 100,000 parts in five days at a temperature of 65° Fahrenheit.

Legal Notes—*continued*

A similar standard was also agreed to in 1933, with the Chesham Urban District Council, and approved by the Bench of Magistrates following proceedings against that Council in respect of the effluent from their Sewage Farm at Chesham.

In addition, as regards the Hertfordshire County Council Act, the test for putrescibility is included as follows:—

> The effluent shall comply with the incubator test for putrescibility, that is to say the effluent when incubated for a period of five days at a temperature of 80° Fahrenheit in a completely filled and closely stoppered bottle (of not less than 125 millimetres capacity) shall be free from offensive odour and shall not become dark coloured.

(e) **Lancashire County Council (Rivers Board and General Powers Act, 1938)**

By this Act, the two joint Pollution Committees set up by Provisional Orders in 1891 for the Rivers Ribble and Mersey and Irwell were dissolved, and a new Board, the Lancashire Rivers Board, was constituted to administer the Rivers Pollution Prevention Act, 1876, for the whole of Lancashire (with certain exceptions) and areas in Cheshire and North-West Derbyshire, draining to the upper part of the River Mersey.

The Act confers special powers on the Board for the control of the deposit of solids and the discharge of liquid trade wastes and sewage into rivers in the area, and extends the 1876 Act powers for the prevention of pollution.

Conclusion

I have endeavoured to give some idea of the appreciable amount of legislation which exists for the protection of the country's rivers and streams from pollutions of various kinds, and, having regard to the scope of the same, it would appear that if the law was in every case strictly enforced, we might reasonably expect to find "drinking water" conditions in our rivers and streams. That such conditions have not been attained generally is well known, but this, as already indicated, is not due to any lack of legislation, but rather to inadequate administration of the law, to some extent, brought about by certain overlapping of the responsible authorities in various Catchment Areas. This, as you may be aware, does not apply to the Conservator's area.

However, it may be that the implementing of the recommendations contained in the recent Third Report of the Central Advisory Water Committee (the Milne Report) relating to the setting up of River Boards throughout the country will result in a more effective application of the law relating to the prevention of pollution as it is apparently proposed to model the River Boards on the lines of the Thames Conservancy Board so that each Catchment Area, or Group of Catchment Areas, will be under the control of one authority for the purpose of the prevention of pollution of rivers and streams.

(To be continued)

TO CRANE MAKERS.

The Dublin Port & Docks Board is prepared to receive Tenders for supply, delivery and erection of 24 Four-Ton Level Luffing Electric Portal Wharf Cranes and 3 Sets of Electric Control Gear for existing Cranes.

All Cranes will be standard in all respects except portal gauge.

Delivery of the first 8 cranes will be required at the earliest possible date and deliveries thereafter should be at the rate of 6 annually.

Outline Specifications and Drawings can be obtained and Conditions of Contract inspected on application to the Engineer's Office, Dublin Port & Docks Board, East Wall Road, Dublin, C.10, on payment of a deposit of £5, which will only be returnable on receipt of a bona fide tender.

The successful Tenderer will be required to enter into a sealed Contract, which will include provision for variations in costs of labour and materials.

Sealed Tenders, endorsed on the outside, "Tender for Cranes," must be sent to the Secretary, Dublin Port & Docks Board, 19, Westmoreland Street, Dublin, so as to reach him not later than Wednesday, 3rd July, 1946.

The Board does not bind itself to accept the lowest or any Tender.

By Order,
R. F. LOWE,
23rd May, 1946.

Port & Docks Office,
Dublin.

GOVERNMENT SURPLUS STORES.

The Ministry of Supply have for immediate disposal the following Sub-Assemblies ex. Mulberry Harbour, located as shown:—

Lot 1.—BUFFER PONTOONS, in Serviceable Condition.

Brief specification:—

A tapered Pontoon of cellular internal construction, constructed from about 300 Tons of 3/8-in. Steel Plate and some joist material.

Having two low-pressure compressors and a piping system in the Pontoon connected to water ballast compartments.

The deck of the Pontoon is overlaid by a rail grid set in about 4-in. of concrete.

Size approx. 80-ft. by 50-ft., tapering from about 10-ft. at back to a few inches at front.

Location:—ONE Pontoon lying in Millwall Docks.
SIX Pontoons lying at Southampton.

Lot 2.—CONCRETE FLOATS OR BARGES.

Brief Specification:—

Hollow Concrete Floats or Barges with covered deck. Constructed from reinforced precast concrete panels.

(a) Location:—79 Floats lying at Southampton in serviceable condition.
(b) 12 Floats lying at Southampton, damaged.
(Size approx. 41-ft. 9-in. long x 15-ft. 3-in. beam x 9-ft. 3-in. deep. Weight approx. 45 tons each).
(c) 32 Floats lying at Southampton in serviceable condition.
(d) 14 Floats lying at Southampton, damaged.
(Size approx. 41-ft. 9-in. long x 18-ft. 9-in. beam x 8-ft. 9-in deep. Weight approx. 55 Tons each).
(e) 2 Floats lying at Barrow-in-Furness.
(Size approx. 50-ft. long x 22-ft. beam x 4-ft. deep).

Lot 3.—SHORE RAMP FLOATS.

Brief specification:—

A floating steel ramp of shallow draft and light construction. Built up from four sections each 80-ft. long and 7-ft. 6-in. wide, each section being completely welded and watertight. Sluice valves are provided in section at back. Fitted with handrail standards and two 5-Ton hand winches, with Warping Drums.

Size approx. 80-ft. by 30-ft. when assembled, 7-ft. deep at back tapering to approx. 1 ft. at front. Weight approx. 45 Tons.

Location:—5½ lying at Southampton in serviceable condition.

Arrangements for inspection can be made by prior application in writing to The War Office Director of Transportation (T.N. 2, 1a), Metropolitan Buildings, Northumberland Avenue, London, W.C.2. Purchasers must take delivery as and where lying and will be responsible for dismantling and removal from the site after the issue of Release Instructions.

Offers for all or any part of one or more lots are invited. They should be addressed to:—

Ministry of Supply,
Director of Contracts,
Great Westminster House,
Horseferry Road,
London, S.W.1

to arrive not later than 10 a.m. on 28th June, 1946. Envelopes must be marked "Tender No. 942801, returnable 10 a.m., 28th June, 1946." Failure to mark the envelope correctly may result in a Tender not being considered.

Any contracts made as a result of this tendering will be subject to the Department's usual Conditions of Sale (Form C.C.C./Sales/1), a copy of which may be obtained, if desired, from the Ministry of Supply, Contracts Directorate (S.C.B. 4), Great Westminster House, Horseferry Road, London, S.W.1. Reference No. 942801 should be quoted when applying for this Form.

GREENOCK HARBOUR TRUST.

APPOINTMENT OF HARBOUR MASTER.

The Greenock Harbour Trustees are prepared to receive applications from suitable candidates holding Master's or Extra Master's Certificates for the appointment of Harbour Master at the Port and Harbours of Greenock, at a commencing salary of £500 to £550 per annum, according to qualifications and experience; applicants to be not more than 50 years of age and preferably with general port traffic experience. The post is an established one with superannuation privileges, and the successful applicant will be required to commence duties about the beginning of November, 1946. Applications, giving full particulars of experience and qualifications, should be lodged with the Undersigned not later than 31st July, 1946. Canvassing, directly or indirectly, will disqualify a candidate.

DONALD SMITH,
General Manager and Engineer.

Harbour Offices,
Customhouse Quay,
Greenock.

29th April, 1946.